Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

APRIL, 1955

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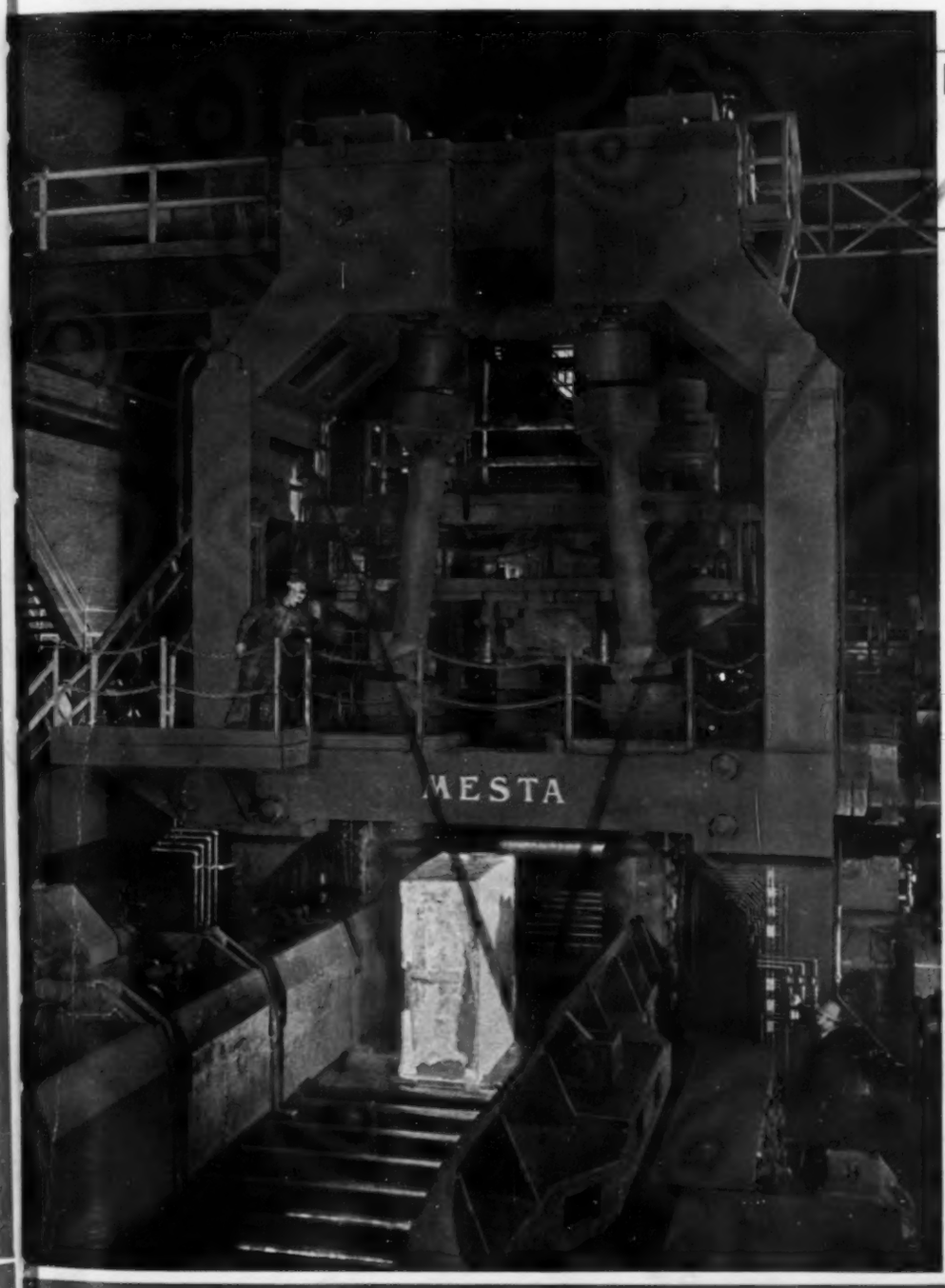


Rolling 20 Ton Ingots into Slabs on a Mesta 45"x90" Universal Reversing Slabbing Mill

Designed and Built by MESTA

SLABBING MILL

for GREAT LAKES STEEL CORPORATION
DIVISION OF
NATIONAL STEEL CORPORATION

Designers and Builders of Complete Steel Plants

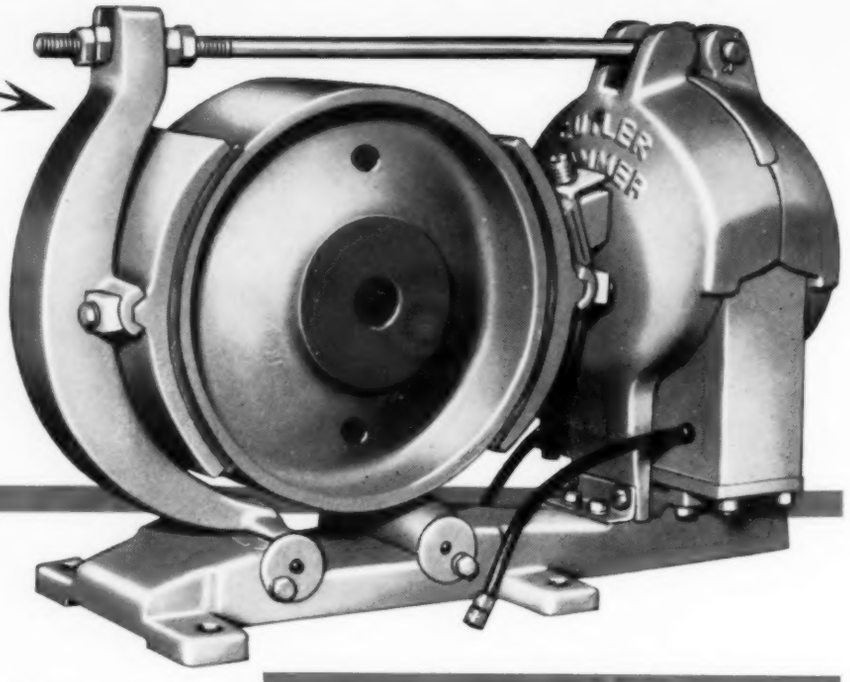
MESTA MACHINE COMPANY

PITTSBURGH, PENNSYLVANIA

THE

NEW

CUTLER-HAMMER BULLETIN 505 AISE MILL BRAKE



It stands alone for simplicity, dependability, durability and ease of maintenance

This is an amazing new brake, amazing in its simplicity, accessibility to all parts, ease of maintenance, durability and dependability . . . all the qualities that mean so much to mill operating personnel. It fully complies with new NEMA Standard and AISE Standard No.11 of Sept. 1952. It has a minimum of parts with direct, simple operating design. Troublesome pivot pins have been eliminated. In their place, oversize bearing surface joints and sockets are used which reduce bearing pressures to a fraction of any other mill brake. The new weatherproof capsule coil easily inserts as a unit between the two armatures and as easily removes as a unit. Out-of-action time is reduced to the period required to get a replacement coil from stock and bolted into place. Two movable armature members move the brake shoes, one directly, the other by means of the efficient, C-H originated over-the-wheel pull rod. This construction transmits braking force directly and eliminates bell cranks, cantilevers, and other troublesome means of transmitting power around a corner. It permits the shortest stroke, the most efficient braking action of all. Shoe travel is adjusted independently while the torque is set at a definite value; all segments of shoes travel at right angles to wheel circumference. These features remove the possibility of lining drag and excessive wear. Wide adjustment range facilitates ease of installation and alignment of brake with respect to motor. Shoes can be removed while wheel is running. The entire brake is disassembled and reassembled, easily, with the use of one wrench.

There are too many outstanding features to be covered on this page . . . features that *do* make this brake *the* brake of your choice. Write for complete descriptive literature and see why this should be your next brake buy. Write today . . . CUTLER-HAMMER, Inc., 1255 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associates:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

THESE ARE THE SIMPLE, CLEAR, OBVIOUS ADVANTAGES OF THE NEW C-H BULLETIN 505 BRAKE

1. Built to new AISE and NEMA Standards.
2. Simplicity and ruggedness apparent at a glance.
3. Direct action over-the-wheel construction for maximum braking effectiveness. The only brake with one to one ratio leverage.
4. Oversize bearing surfaces that with over-the-wheel pull rod cut bearing pressure and wear to a fraction of that of any other brake.
5. Weatherproof capsule coil bolted to base between two movable armatures. Easily removed as a unit, easily replaced as a unit. Reversible too.
6. There are but two simple adjustments. "Feel" type sounding pins tell easily and surely when to make adjustment—*and when adjustment is correctly made.*
7. The brake that retains the fundamental principle that for decades has made the Cutler-Hammer Mill Brake the standard of the industry.

CUTLER-HAMMER
MOTOR CONTROL
C-H

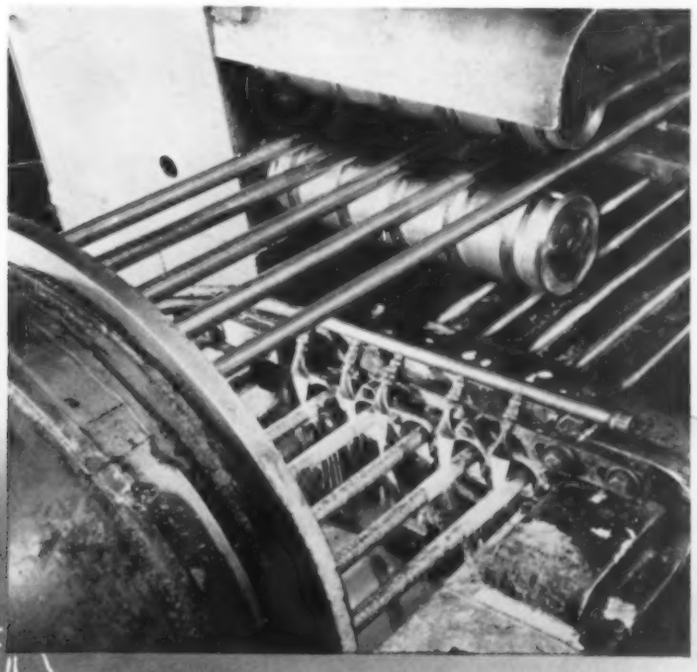
IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., Pittsburgh, Pa. Second class mail privileges authorized at Pittsburgh, Pennsylvania, January 25, 1924.

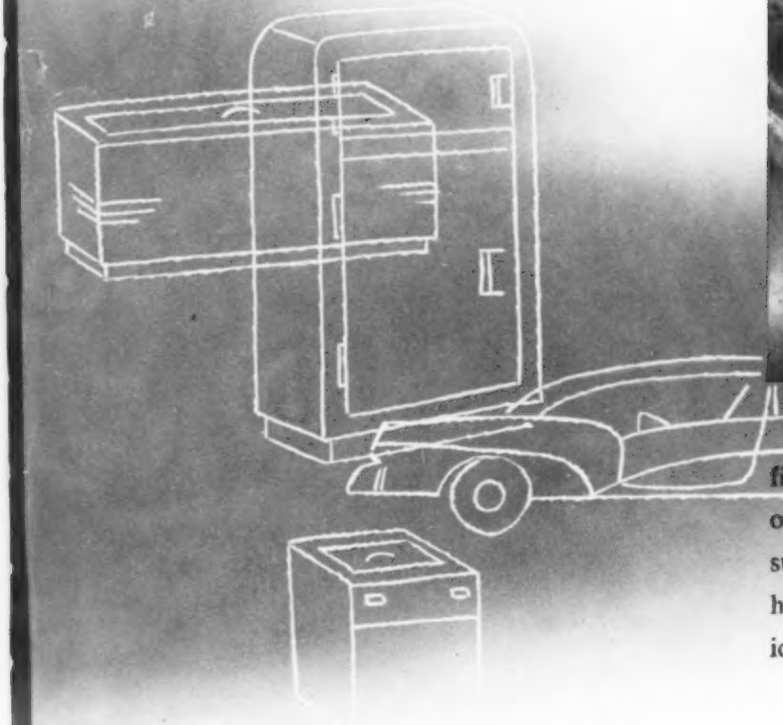
where goes AMERICA?

America will buy ninety million more home appliances in the next five years than the past five years . . . about 428 million units in all.

Appliances require great tonnages of steel, copper, brass, aluminum, other metals, rubber and plastics. Consider copper and copper alloys—25 pounds in a refrigerator—23 pounds in a home freezer—12 pounds in a washer. In a well-constructed six-room house—2,400 pounds plus 45 pounds in the family automobile.

Do you have the best cold draw equipment to produce the volume or will you lose ground to competitors with more efficient equipment?





How many tubes can you draw at one time? Here are five going through at the same time, a recent development of Aetna-Standard. How about your carriages? Aetna now supplies air-operated carriages, much more efficient than hydraulic-operated. Aetna has many more cold draw profit ideas.

SUBSIDIARY and ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.
Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.
M. Castellvi, Inc., New York, N. Y. — Mexico, Central and South America.
Societe de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.
Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.
Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.
Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.
Hale & Kullgren, Inc., Akron, Ohio — Representative for the Rubber Industry.
Standard Engineering Company, Ellwood City, Pa.
Trans-World Traders, Pittsburgh, Pa.

Designers and Builders to the Ferrous, Non-Ferrous, Leather, Rubber, and Plastic Industries

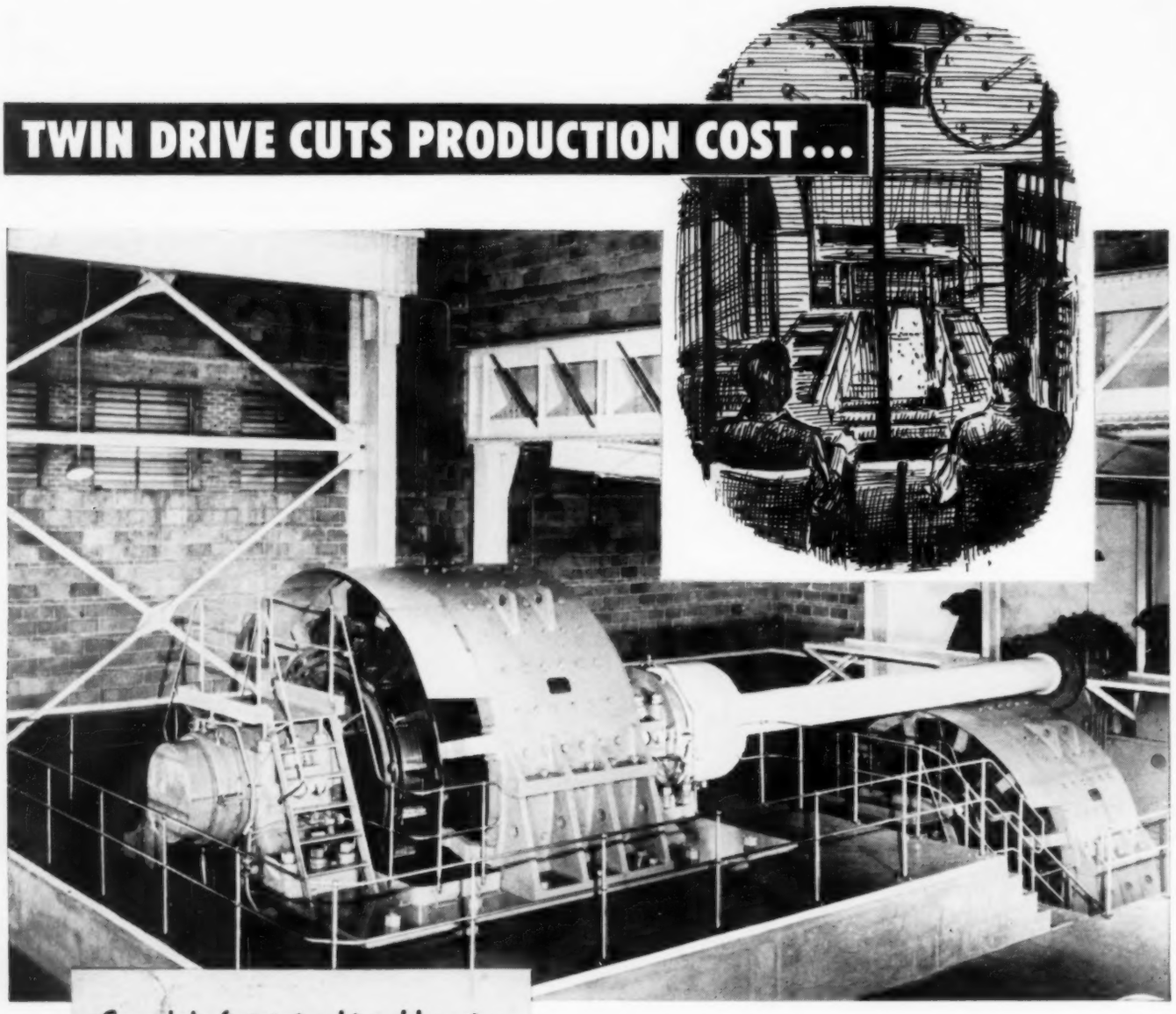
THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

TWIN DRIVE CUTS PRODUCTION COST...



Canada's first twin drive blooming mill is cutting production costs for Dominion Iron & Steel Limited, a subsidiary of DOSCO.

The twin drive, where each work roll has its own motor —

- **eliminates pinion housing and saves an energy loss of approximately 4 to 5%**
- **cuts out pinion lubrication and maintenance costs**
- **cuts reversing peak current by reduced motor inertia**
- **reduces roll wear by cutting out slip due to different roll diameters**
- **provides increased rolling efficiency**

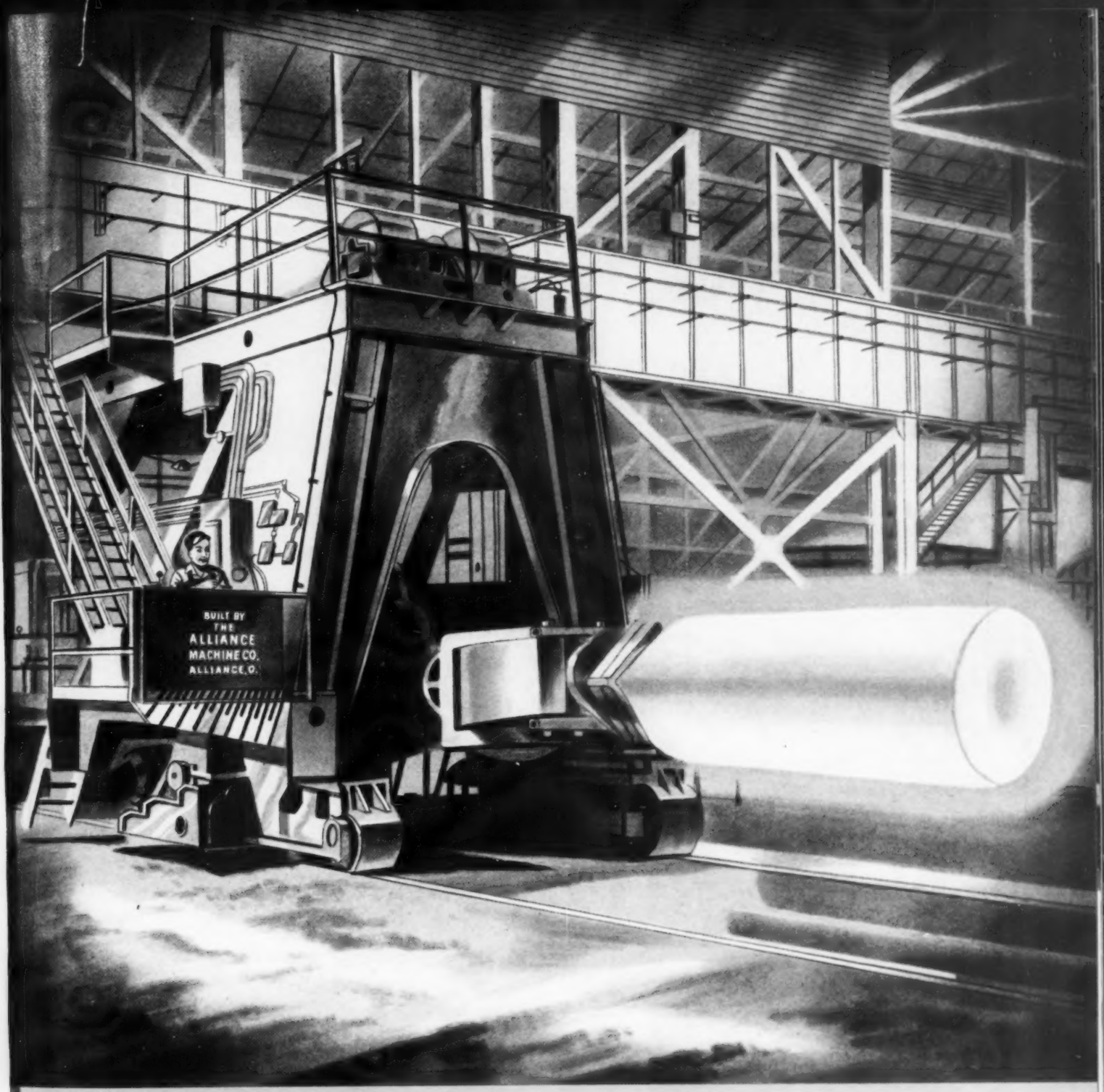
Each motor in this installation at Dosco's Sydney plant develops a peak of 10,500 H.P.; together give a total of 21,000 H.P.

PA5409

For thirty years, English Electric have built drives for hot and cold rolling mills of every kind and the value of this experience is yours for the asking. If you have a mill drive problem, whether it be power supply, substation, cabling, ventilating or complete layouts, give us a call. Our publication MT/108 describing the rolling mill twin drive is available on request.

ENGLISH ELECTRIC

Vancouver, Calgary, Winnipeg, Toronto, Ottawa, Montreal and Halifax.
English Electric Company of Canada Limited, St. Catharines, Ontario.



Alliance

20-TON FORGING MANIPULATOR

The Alliance Machine Company builds manipulators for all types of forging work.

The manipulator shown here is designed to handle 20-ton ingots and is equipped with hoist, leveling device, longitudinal motion and power grip revolving tongs.

This manipulator is effectively cushioned to reduce impacts, thereby reducing jar to operator and equipment.

By means of finger-tip control operator can regulate all motions from sitting position.

Give Us The Runway And We'll Lift The World

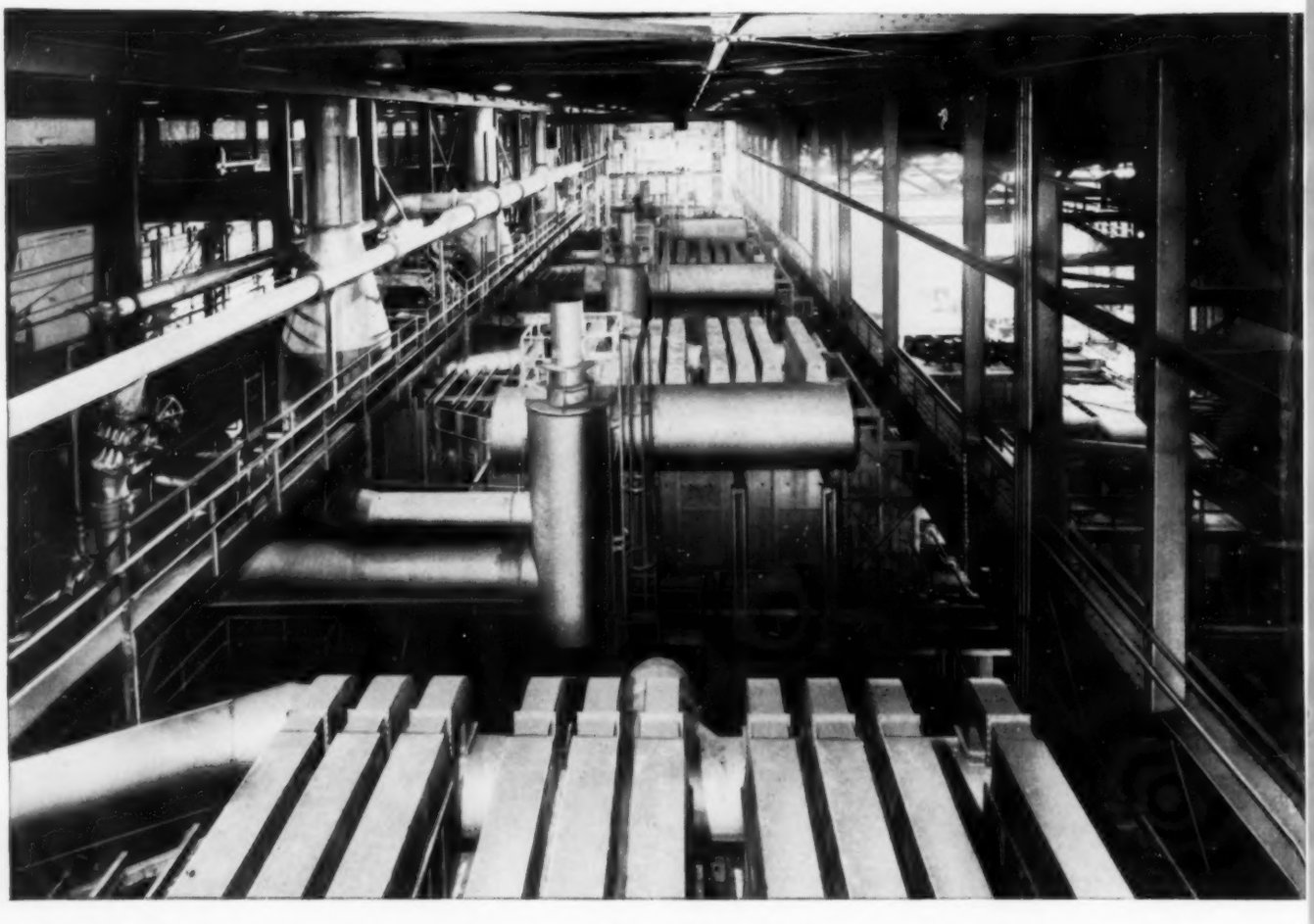
THE ALLIANCE MACHINE COMPANY

FOUNDED 1901 • MAIN OFFICE: ALLIANCE, OHIO

World's largest builders of world's largest cranes

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES
STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

HAZEN METALLIC RECUPERATORS



Hazen Metallic Recuperators installed above 4 new Slab Reheating Furnaces at Fairless Works, United States Steel

the only 100% American Metallic Recuperator

- **Entirely made in U.S.A. All inner and outer tubes made of Stainless Steel.**
- **This application takes advantage of the natural upward flow of flue gases.**
- **Less stack draft is required.**
- **Increased preheat . . . due to availability of a larger percentage of flue gases at higher temperatures.**

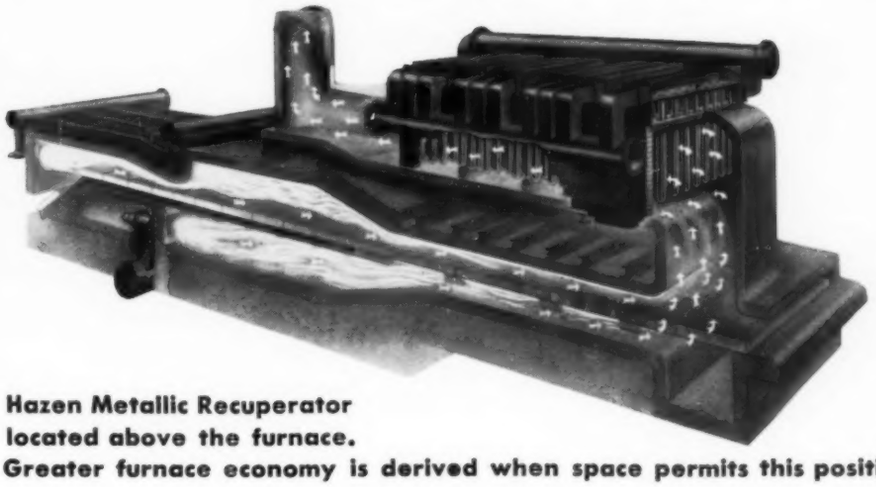
Consult us about improving the production and economy of your furnace operations

improve FURNACE production and economy

by taking advantage of

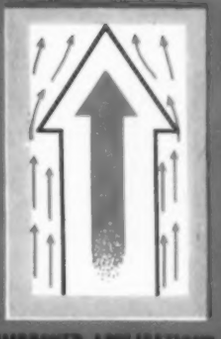
What Comes Naturally

in the flow of flue gases from the furnace to the recuperator



Hazen Metallic Recuperator
located above the furnace.
Greater furnace economy is derived when space permits this position.

CONVENTIONAL APPLICATIONS
RESIST
THE NATURAL UPWARD
FLOW OF GASES



IMPROVED APPLICATIONS
ASSIST
THE NATURAL UPWARD
FLOW OF GASES

- **Economies in initial cost . . . by reducing the required amount of excavating and furnace foundation . . . by reducing the length of flue ordinarily required from furnace to stack.**
- **Recuperator, flue and stack may be supported from steel work independent of the furnace bindings.**
- **Walkways may be provided around the recuperator for convenience of inspection and cleaning.**
- **Recuperator may be applied above an existing furnace with a minimum loss in outage time.**

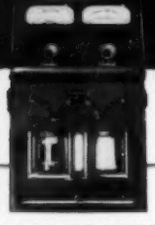
HAZEN ENGINEERING COMPANY

PARK BUILDING • PITTSBURGH 22, PA.

TELEPHONE: COurt 1-7030

THIS IS INLAND STEEL!

The Cities Service Heat Prover Works Here



THE PORTABLE HEAT PROVER is supplied and maintained free by Cities Service. It helps control combustion efficiency by allowing rapid, continuous sampling, simultaneous readings and direct measurement of oxygen and combustibles. Inland uses the Heat Prover for its blast furnaces, open hearths, soaking pits, continuous galvanizing line, reheat furnaces, purging operations, annealers, and boilers on ore ships.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

40-inch Blooming-Slabbing Mill

at Fairless Works of United States Steel

This two-high reversing mill at U. S. Steel's Fairless Works was designed and built by CONTINENTAL Foundry & Machine Company for intermediate rolling of blooms and slabs. This mill has given an excellent account of itself in Fairless production.

The rigid design that goes into *every* CONTINENTAL mill helps get you out of production problems, enables you to drive these mills hard—continuously—without running into trouble. This, coupled with well-designed auxiliary equipment, assures smooth operation as well as continuity of production. This mill and complete auxiliaries were built entirely at CONTINENTAL'S Wheeling Works, West Virginia.

You may know that CONTINENTAL has fully integrated facilities for design, engineering, production and erection of a full range of complete rolling mills, auxiliary equipment, special heavy machinery, and bar and tube straightening equipment. Also facilities for fine steel castings, iron and steel rolls, and weldments, as well as boiler cleaning and control equipment. We'll be glad to discuss your requirements.

CONTINENTAL

Engineering and Sales Office, 220 Grant St., Pittsburgh 19, Pa.
***Plants at* East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.**
***Copes-Vulcan Division*, Erie, Pa.**

CONTINENTAL
Foundry & Machine
Company

Large Mill Erection Floors
Assure Efficient, Quality Workmanship

Top-quality manufacturing of rugged, costly rolling mills demands checking facilities which insure easy installation and continuity of operation. CONTINENTAL has two large erection floors 60 x 300 feet for erecting and checking before shipping. They are centrally located in our nation's largest steel producing areas, one in East Chicago, Indiana, and another in Wheeling, West Virginia.

The Chicago floor pictured above allows for assembly of a 46" Blooming-Slabbing mill concurrently with a 56" Tandem Cold Strip mill. Here the mill stands, together with all auxiliary equipment, are shop-erected to assure satisfaction of erection at installation. It is CONTINENTAL's way of making sure "there is nothing better than a CONTINENTAL mill."

In either the East Chicago Works, or the Wheeling Works, CONTINENTAL, with a full range of large machine tools, is able to serve our customers by helping them with current maintenance operations to minimize downtime.

CONTINENTAL has fully integrated facilities for design, engineering, production and erection of a full range of complete rolling mills, auxiliary equipment and special heavy machinery. Also facilities for fine steel castings, iron and steel rolls, weldments as well as Copes-Vulcan boiler cleaning and control equipment. We'll be glad to discuss your requirements.

CONTINENTAL

CONTINENTAL
Foundry & Machine
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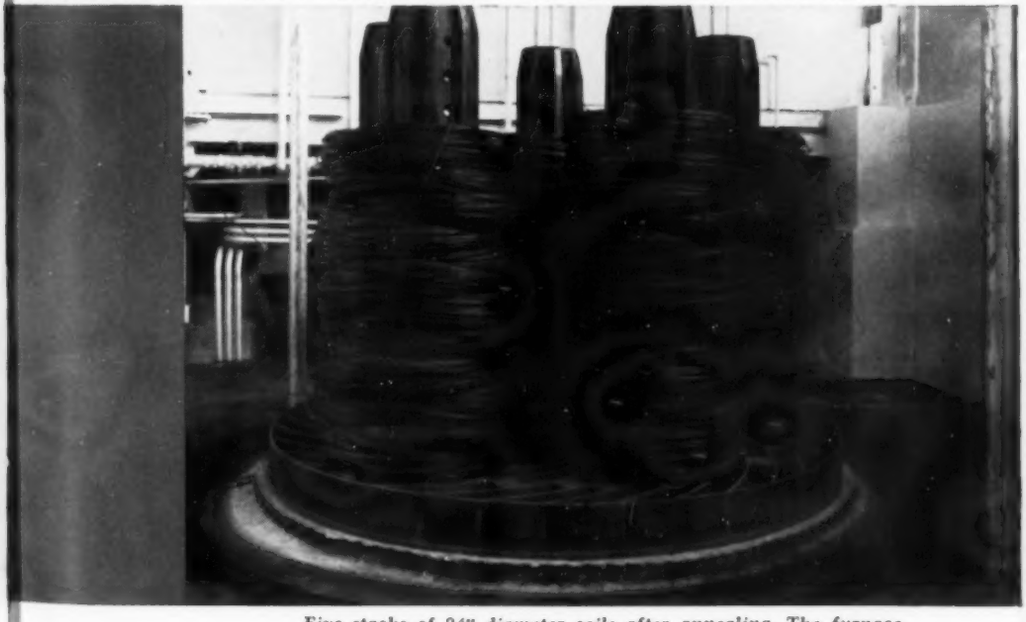
Engineering and Sales Office, 220 Grant St., Pittsburgh 19, Pa.
Plants at East Chicago, Ind. • Wheeling, W. Va. • Pittsburgh, Pa.
Copes-Vulcan Division, Erie, Pa.

SUPER BELL TYPE ANNEALING FURNACES BOOST ROD and WIRE PRODUCTION — IMPROVE QUALITY

Largest diameter circular radiant tube annealing furnace in operation today was recently started up at one of the nation's foremost rod and wire manufacturers. It consists of three huge 108" furnaces and five bases. This same concern has more of these on order.



Five stacks of 34" diameter coils after annealing. The furnace is large enough for three stacks of 48" diameter rod coils.

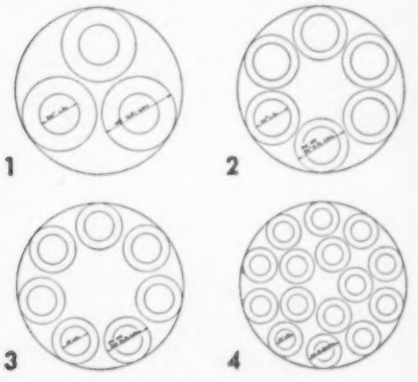
Big 108" diameter furnaces that wi hold three stacks of 48" diameter rod co were recently set into operation by on of America's leading rod and wire maker to step up production of these new large coils. Designed and built by Lee Wilso the nation's foremost manufacturer radiant tube, bell type annealing fu naces, the units are the largest of the kind in commercial production today.

After the shakedown runs the man facturer called the equipment "high satisfactory," and scheduled simila furnaces for a second plant. The furnac not only gave this manufacturer th capacity he wanted, but stepped up BT intake and special diffuser assemblie gave him faster anneals of greatly im proved quality.

If you process wire or rod, you'll wa the full story of these big, modern, hig production units. Simply write Lee W son Engineering and a qualified L Wilson engineer will call on you at you convenience.

CHARGE PATTERNS

CHARGE VERSATILITY is emphasized by these typ loading patterns. Regardless of coil size, you can take advantage of this 108" diameter base.



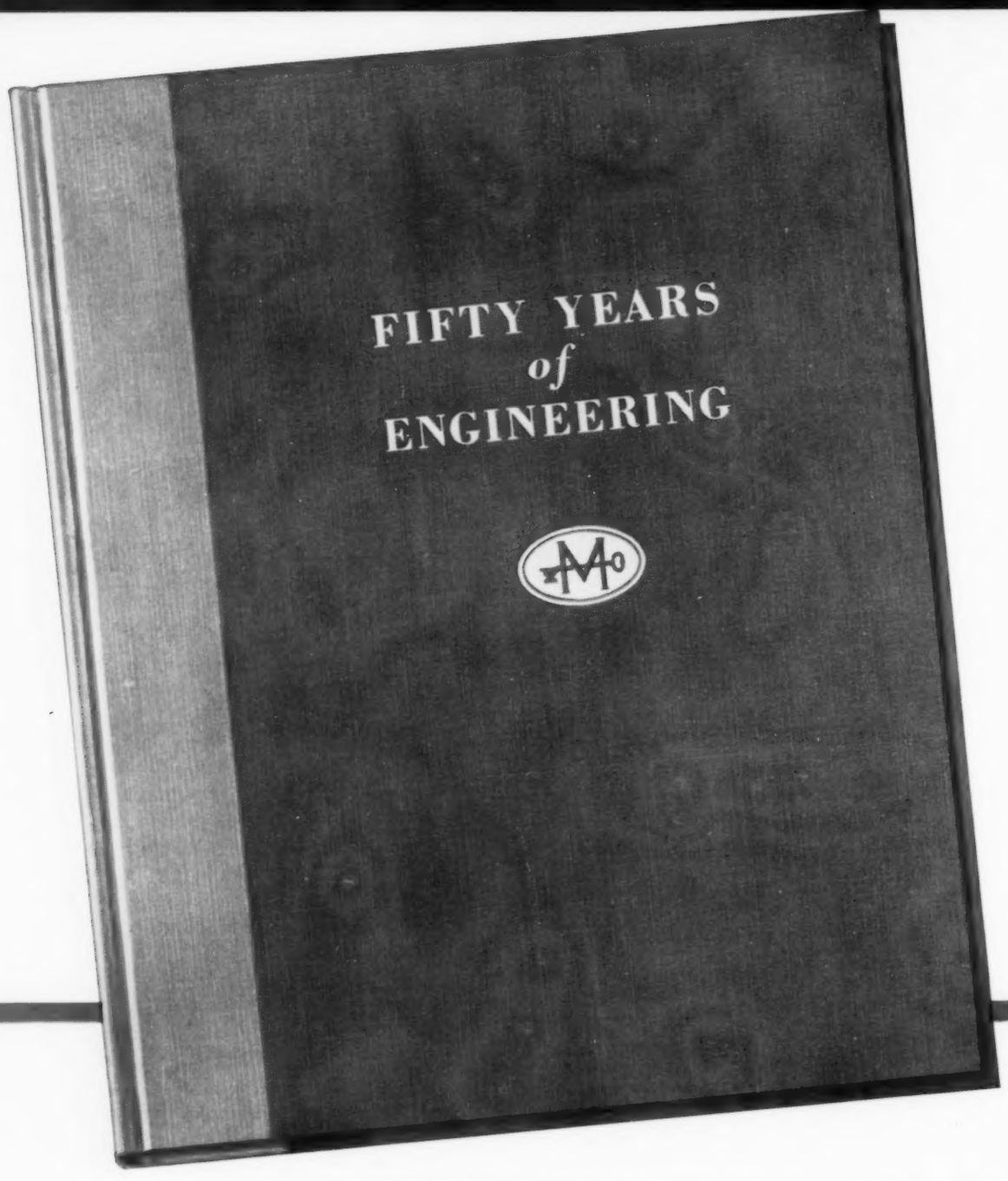
TABLE

Load	Coil Size	No. Stems per Charge	Weight per Stem	T Ch (L
No. 1	Rods (48")	3	6000	18
No. 2	26" Block 35" OD x 24" ID	6	4500	27
No. 3	22" Block 29" OD x 19" ID	7	4500	31
No. 4	16" Block 22" OD x 13" ID	15	2500	37

Lee Wilson

ENGINEERING COMPANY, Inc.

20005 West Lake Road, Cleveland 16, Ohio



THE YEAR 1955 marks the Fiftieth Anniversary of the founding of Arthur G. McKee & Company.

Since 1905 this company has had a continuous, successful record of fifty years of engineering, designing, building in every quarter of the globe—fifty years of accumulating knowledge and experience—fifty years of building an organization with the specialized abilities, the scope and resources to undertake projects of any size in any location.

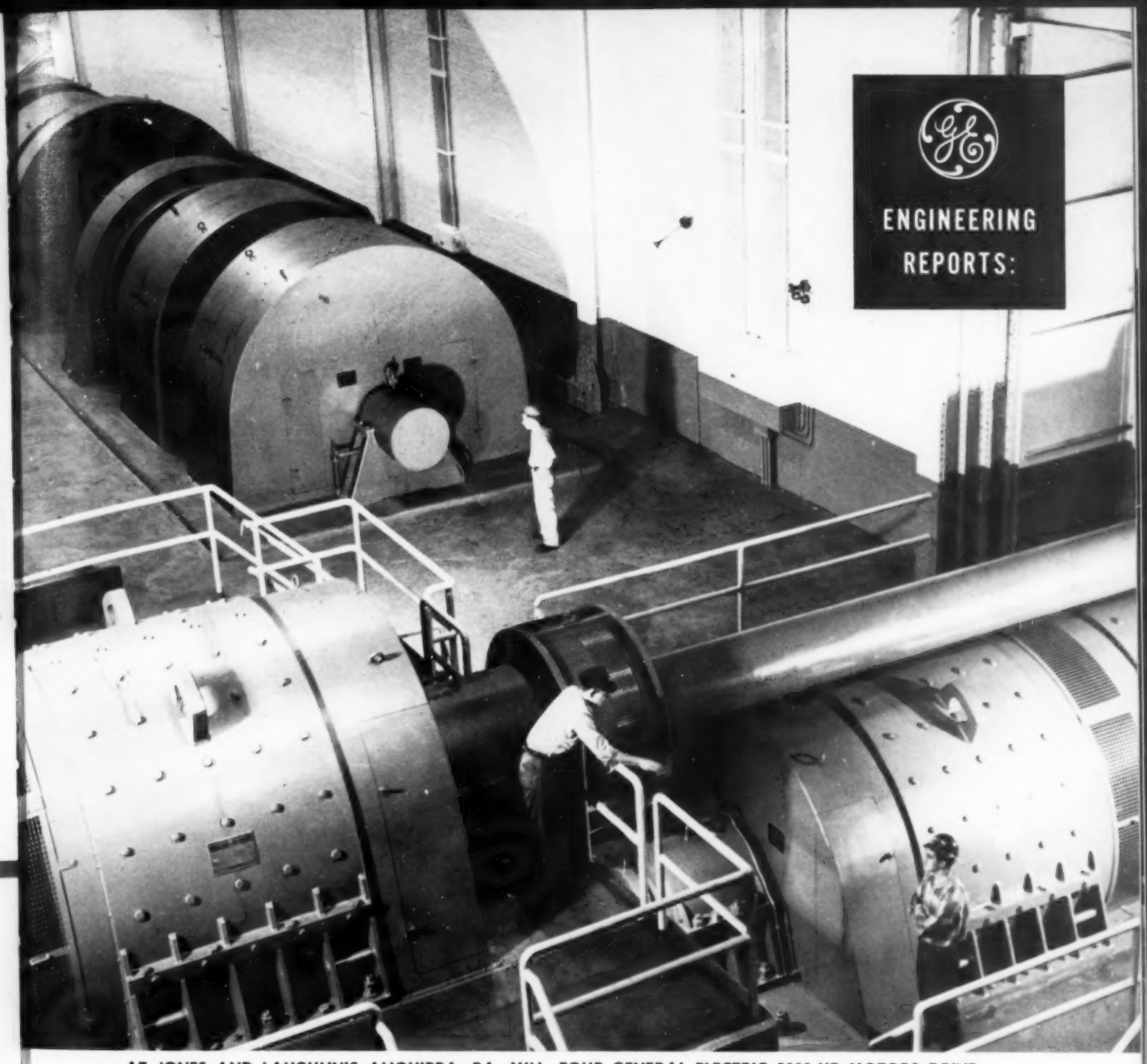
The sound, practical engineering methods and thorough, painstaking construction techniques developed in a half-century of McKee history can be invaluable to you on your new plant project, as they have been to hundreds of McKee clients in the past.

50th ANNIVERSARY

McKee Engineering Services

Arthur G. McKee & Company • Engineers and Contractors

Headquarters: McKee Building • 2300 Chester Avenue • Cleveland 1, Ohio
Offices: New York • Tulsa, Oklahoma • Union, N. J. • Washington, D. C.
British Representatives of Metals Division: Head, Wrightson & Co., Limited
Canada: Arthur G. McKee & Company of Canada, Ltd., 372 Bay St., Toronto



AT JONES AND LAUGHLIN'S ALIQUIPPA, PA. MILL, FOUR GENERAL ELECTRIC 3000-HP MOTORS DRIVE . . .

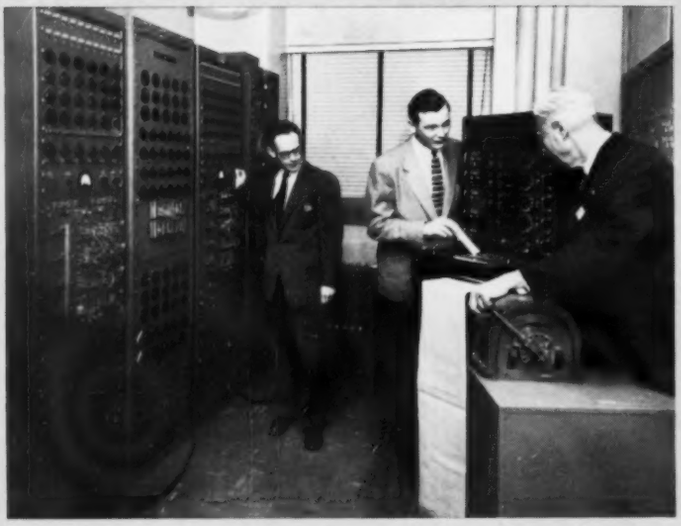
Record-breaking reversing blooming mill

Jones and Laughlin's 44 in. blooming mill at Aliquippa, Pa., has smashed all previous world production records for small ingots. Powered by a coordinated General Electric drive system, this mill which is reversed from 70 rpm to 70 rmp in one second, has rolled 576 ingots in one eight hour shift—a 10 per cent increase over the old record set by the same mill when it was steam-driven.

J&L's conversion from steam to electric drive was an outstanding feat. In only 7 days, 14¼ hours the mill was back in full, around-the-clock production. This was more than two days ahead of the schedule set up for the changeover. For the story of the conversion and how G-E engineering services aided J&L in this operation see the following pages.

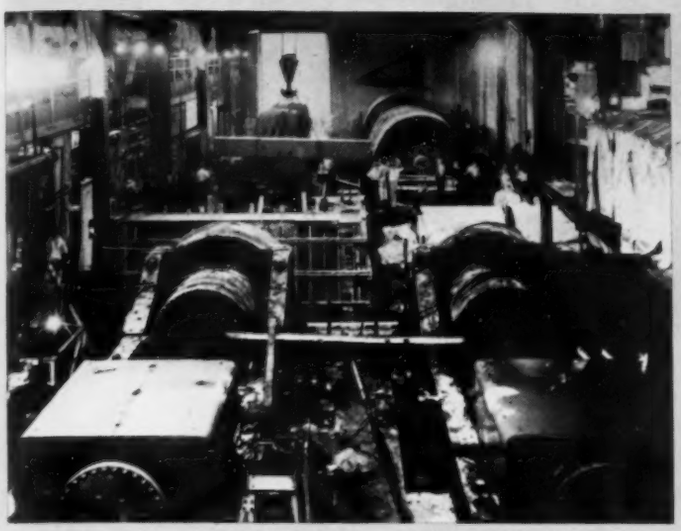
SEE CONVERSION STORY ▶

GENERAL ELECTRIC



GENERAL ELECTRIC engineers pre-determined electric drive system adjustments with electronic differential analyzer, and built wooden scale model of drive to rehearse conversion.

GENERAL ELECTRIC



JONES & LAUGHLIN engineers directed entire conversion, working day and night. Approximately 200 workmen per turn were utilized in the change-over which saw . . .

FULL PRODUCTION RESTORED IN 7 DAYS, 14½ HOURS

To help assure that Jones and Laughlin's conversion from steam to electric drive would be completed within 10 days, and that the new drive would help J&L surpass old production records, General Electric utilized its full range of engineering services.

Working closely with J&L, G-E analytical engineers simulated all operating conditions on an electronic differential analyzer. With G-E product engineers assisting, the design and adjustment of the electrical system were determined after "runs" of the mill on the analyzer were examined. As a result of these computer studies, the drive system was "tailored" to meet the exact requirements of Jones & Laughlin.

To help speed the conversion, a wooden scale model of the 12,000-hp main drive, its foundation and the steam engine foundation was built to study the problems involved in the installation. The model was assembled and disassembled piece by piece as J&L and G-E engineers rehearsed the actual changeover.

More time was saved when the electrical system was designed so that switchgear, m-g sets, exciter sets, control and even ventilating equipment could be installed and tested before the old drive was shut down. G-E field engineers were on hand to assist in the conversion and start-up of the drive.

These G-E engineering services are available to you. They will help save you time and money whether you are planning to modernize, expand, or build. For further information about these engineering services, contact your nearest G-E Apparatus Sales Representative, or send for bulletin GEA-2244. General Electric Company, Schenectady 5, N. Y. 659-106

Engineered Electric Systems for Steel Mills

GENERAL ELECTRIC

DESIGNED TO MEET AISE STANDARDS, a new General Electric single-magnet, two-shoe, direct-current brake is shown installed on a slab depiler at Jones & Laughlin Steel Corporation plant — Cleveland Division. All brake settings are made at one end.

New General Electric d-c brake with single-point adjustment cuts maintenance time at J&L

ONE OF THE FIRST General Electric direct-current brakes with single-point adjustment underwent tests at Jones & Laughlin Steel Corporation's Cleveland Division. On actual rigid application duty J&L found the brake needed a minimum of maintenance and reduced expensive down-time. New design features which won the approval of J&L maintenance personnel are as follows:

ONE EASY ADJUSTMENT with a wrench is all that is needed to correct for lining wear. Even where one lining wears more than the other, a self-centering fulcrum automatically equalizes both shoe clearances.

ARMATURE GAP INDICATOR shows when to make lining wear adjustment. Normal gap position is clearly shown on this readily accessible gage.

SET AND FORGET torque on the new G-E brake, no more adjustments are necessary. Should the brake's rating be changed, torque setting is easily varied to correspond.

BUILT TO AISE STANDARDS the new brake is suitable for both horizontal and vertical mounting under most conditions. It can be right- or left-hand mounted with no change in pins or bolts.

MORE VERSATILE INSTALLATION is possible with the new brake because all necessary adjustments, settings, and connections can be made from one end. This allows the equipment to be mounted within tight space limitations—only one end need be accessible.

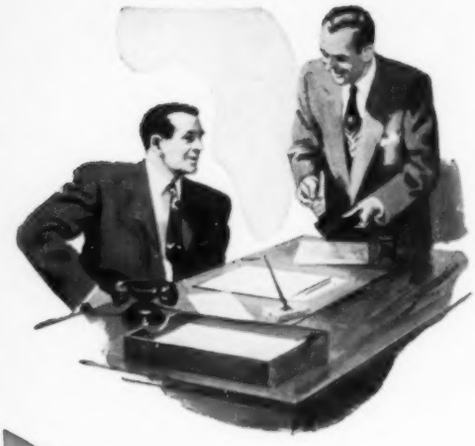
REMOVABLE LININGS can be slipped out with a screw driver after holding bolts are removed—no need to disassemble complete brake shoe.

UNIQUE STRONGBOX MAGNET COIL is easily removable independent of complete magnet assembly. Coil construction seals out dust, moisture, oil, and helps protect windings against mechanical damage.

REDUCE MAINTENANCE and down-time as J&L did—get G.E.'s new d-c brake. For more information contact your nearest General Electric Co. Apparatus Sales Office or send for Bulletin GEA-6214. Section 781-10, General Electric Company, Schenectady 5, New York.

Progress Is Our Most Important Product

GENERAL ELECTRIC



SEE RUST-OLEUM APPLIED DIRECTLY OVER SOUND RUSTED SURFACES! MAKE THIS TEST UNDER YOUR OWN CONDITIONS AND SEE PROOF OF PERFORMANCE!

See Rust-Oleum 769 Damp-Proof Red Primer actually applied over a badly rusted surface after simple scraping and wire-brushing to remove rust scale and loose rust in the Rust-Oleum *"rusted panel demonstration."* Rust-Oleum's specially-processed fish oil vehicle *penetrates* rust to bare metal usually eliminating sandblasting and other costly surface preparations.

Rust-Oleum finish coatings in Aluminum, Green, White, Gray, Yellow, Black, Orange, Blue and others provide both *Rust Prevention* and *Decorative Beauty!* Specify Rust-Oleum for new construction, maintenance, and re-modeling. See Sweets for complete catalog and nearest Rust-Oleum Industrial Distributor, or attach coupon to your business letterhead.

RUST-OLEUM®

STOPS RUST!

There Is Only One Rust-Oleum. It Is Distinctive as Your Own Fingerprint. Resists Rain, Sun, Fumes, Snow, Heat, Salt Air, Salt Water, etc.

See local classified telephone directory under Rust Preventives or Paints for nearest Rust-Oleum Industrial Distributor.

ATTACH TO YOUR BUSINESS LETTERHEAD AND MAIL TO:
Rust-Oleum Corporation, 2444 Oakton St., Evanston, Ill.

- ☐ Please Show Me the Rust-Oleum "Rusted Panel Demonstration."
- ☐ Test Application of Rust-Oleum Over Rusted Metal Surfaces in My Plant.
- ☐ Complete Literature with Color Chart.
- ☐ Nearest Rust-Oleum Industrial Distributor.

Twenty ton mill type bucket crane with 75' span built to A.I.S.E. #6 specifications, over the slag crushing plant in a large eastern steel mill.

20 Ton Bedford Mill Type Crane in slag crushing plant

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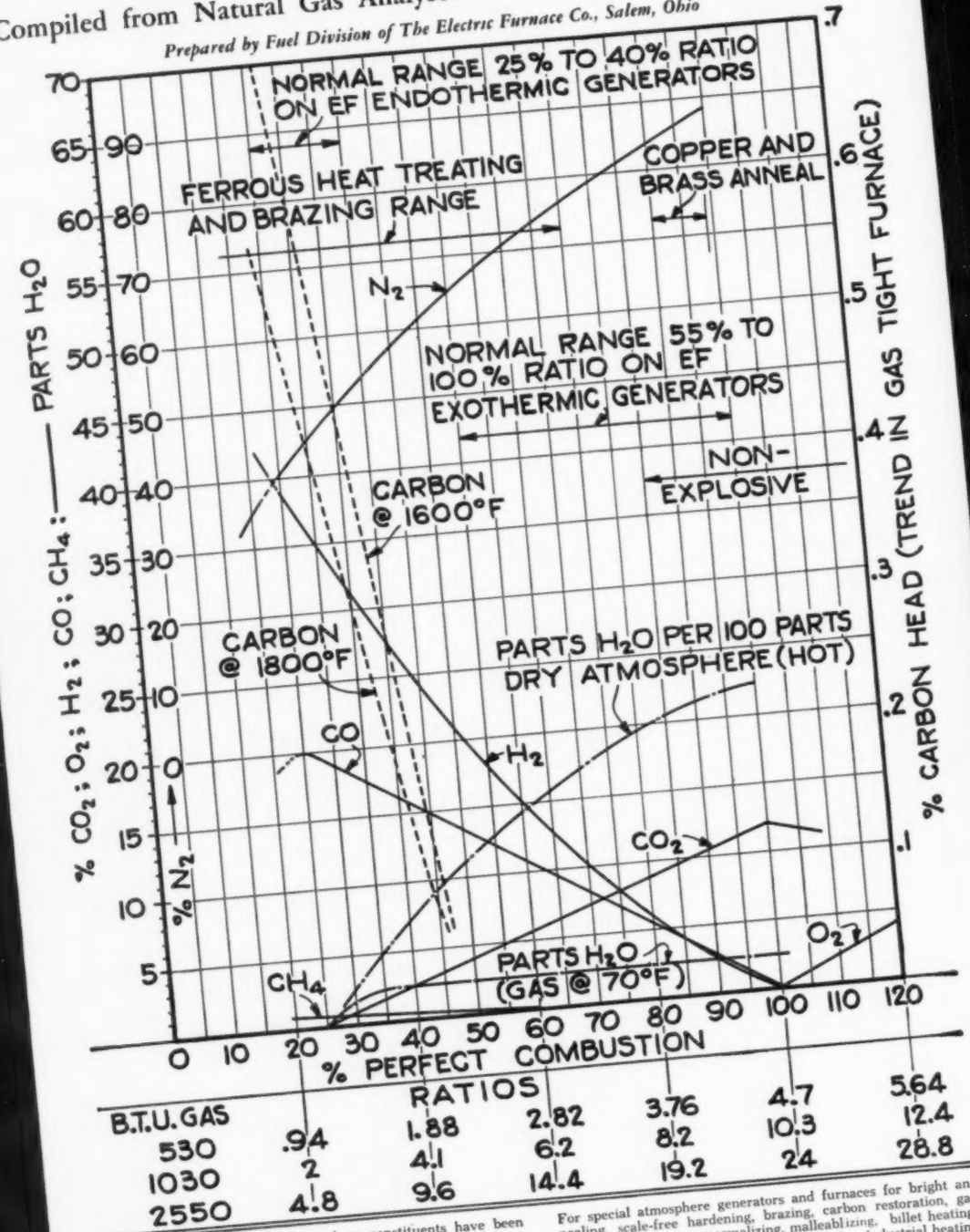
A Ritex basic brick, permanently jacketed in a patented steel shell. Just one of many superior GREFCO products.

Special Atmosphere Chart

Compiled from Natural Gas Analyses (City Gas and Propane Gas will be similar)

Prepared by Fuel Division of The Electric Furnace Co., Salem, Ohio


NORMAL RANGE 25% TO 40% RATIO ON EF ENDOTHERMIC GENERATORS
FERROUS HEAT TREATING AND BRAZING RANGE
COPPER AND BRASS ANNEAL
N_2
NORMAL RANGE 55% TO 100% RATIO ON EF EXOTHERMIC GENERATORS
NON-EXPLOSIVE
CARBON @ 1600°F
CARBON @ 1800°F
PARTS H_2O PER 100 PARTS DRY ATMOSPHERE (HOT)
CO
H_2
CO_2
O_2
CH_4
PARTS H_2O (GAS @ 70°F)
% CO_2; O_2; H_2; CO; CH_4: —— PARTS H_2O
% N_2
% CARBON HEAD (TREND IN GAS TIGHT FURNACE)
% PERFECT COMBUSTION
70 65 60 55 50 45 40 35 30 25 20 15 10 5
90 80 70 60 50 40 30 20 10 0
.7 .6 .5 .4 .3 .2 .1
0 10 20 30 40 50 60 70 80 90 100 110 120

B.T.U. GAS	RATIOS					
530	.94	1.88	2.82	3.76	4.7	5.64
1030	2	4.1	6.2	8.2	10.3	12.4
2550	4.8	9.6	14.4	19.2	24	28.8

Above percentages on gas atmosphere constituents have been averaged from many complete gas analyses. Actual gas analyses compared with above curves will vary slightly due to differences in generator temperature, catalyst, completeness of reaction, raw gas analysis and air-fuel ratio.

Carbon head determinations are obtained by running .001"x2"x2" carbon steel specimens, of high and low carbon, through a gas tight furnace. After exposure to gas atmosphere in furnace for at least twenty minutes (or until equilibrium is reached) the specimens are analyzed for carbon in chemical laboratory carbon furnace. About 8 specimens are required for one chemical analysis.

For special atmosphere generators and furnaces for bright annealing, scale-free hardening, brazing, carbon restoration, gas carburizing, sintering, normalizing, malleablizing, billet heating, heating for forging or equipment for any other industrial heating or heat treating process, consult

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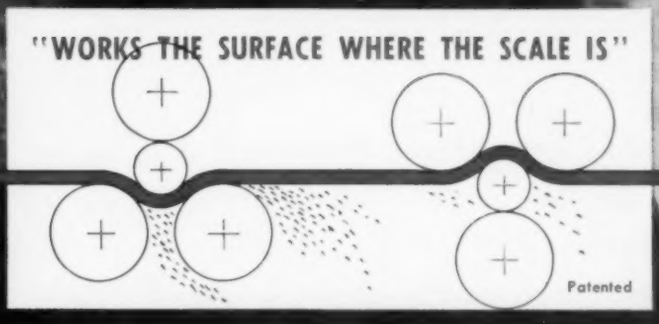

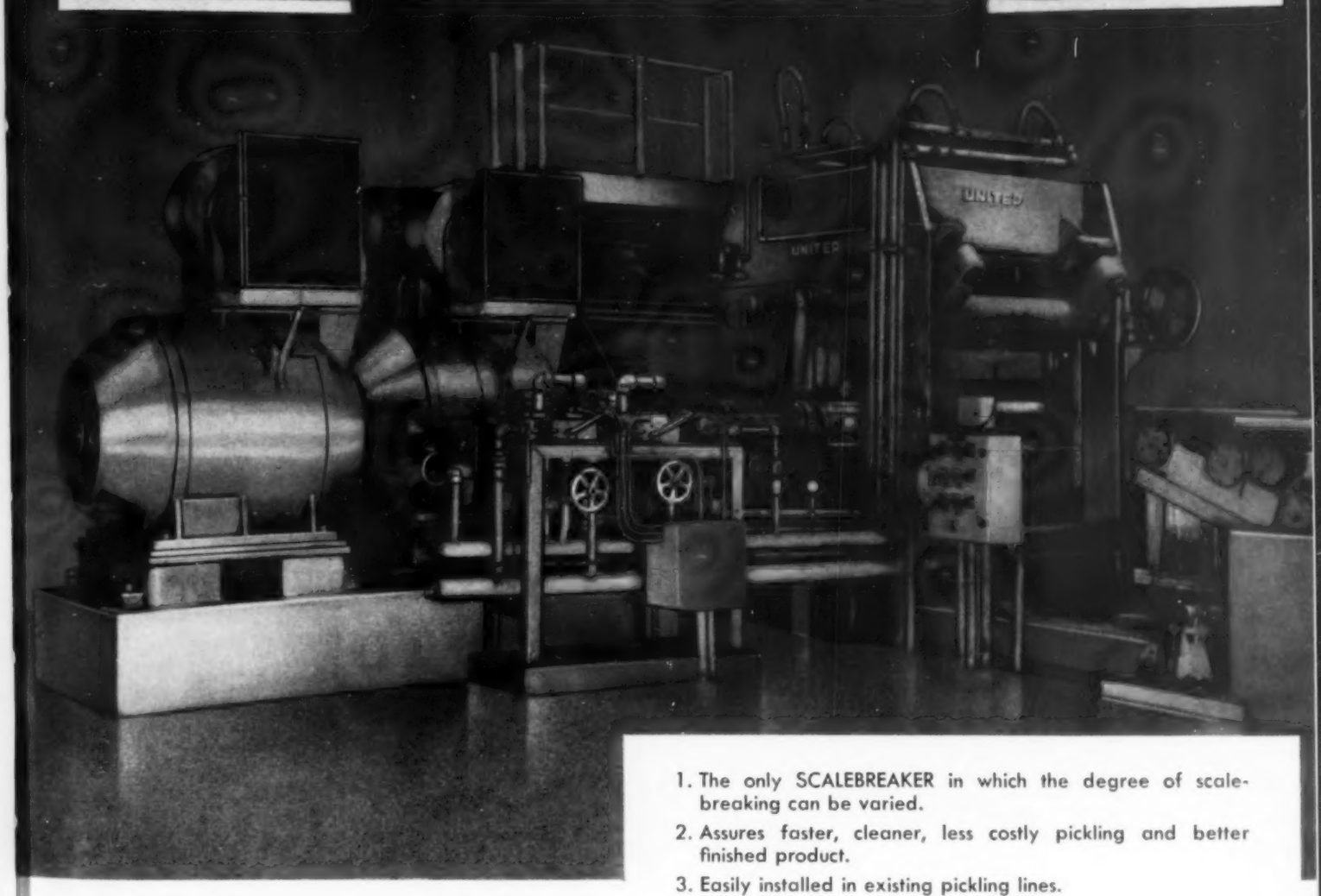

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3. Easily installed in existing pickling lines.

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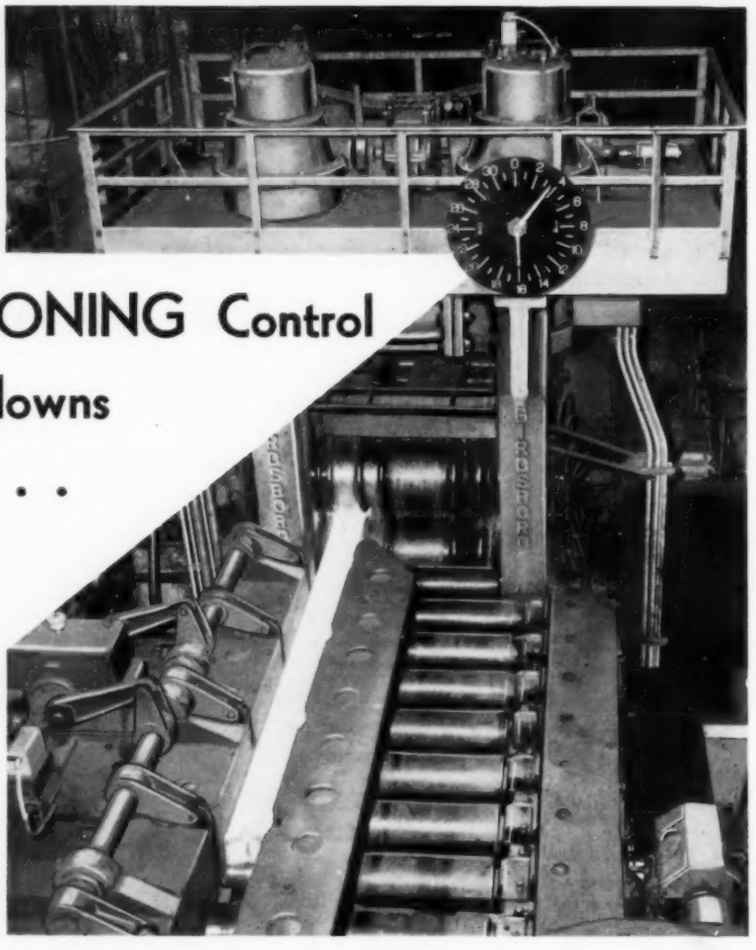

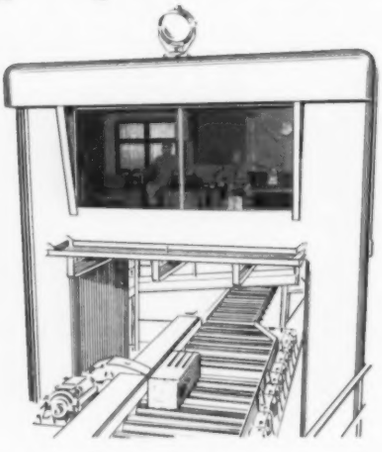

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•—•

New operators learn faster

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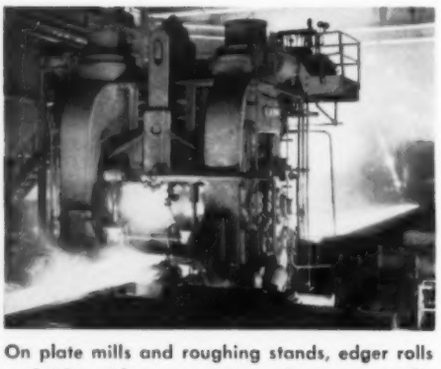
Accurate drafts reduce rejections



On plate mills and roughing stands, edger rolls and side guide movements can be automatically coordinated with screwdown movements.

Indexes *automatically* from pass to pass to speed rolling and cut costs . . .

To meet the challenge of ever-increasing costs, rolling mill management-teams are turning to automatic operation of screwdowns and associated drives. Precise roll drafts give a higher quality product and new operators become seasoned in a shorter time. Removing the need to coordinate the screwdown with mill reversal enables the roller to concentrate on the manipulation of main motor and work tables for faster and more efficient operation.

The roller pushes a momentary-button only once for each pass, and the rolls are driven to the exact pre-selected settings . . . no overtravel with subsequent inching into position. The operation is entirely automatic for each complete rolling schedule.

This EC&M Automatic-Positioning Screwdown Control system is readily applied to ferrous and non-ferrous mills. New Booklet 9250 fully describes this control and shows many interesting installations. Write for your copy.

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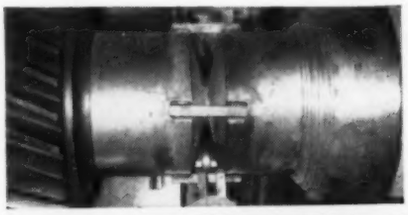
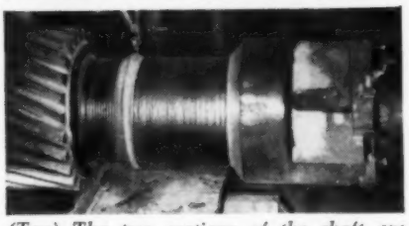
Linde TRADE-MARK METALWORKING NEWS

BROKEN 26-INCH PINION SHAFT BACK IN SERVICE THROUGH "UNIONMELT" WELDING

Maintenance engineers at a large Canadian steel mill took a second look at their cost figures when a 26-inch mill pinion shaft snapped because of metal fatigue. Usually, a broken shaft of this size is valued only as so many pounds of scrap steel and the purchase of a replacement part is required at considerable expense. Spurred on by the possibility of large savings, the engineers decided to fabricate a new section and UNIONMELT weld it to the undamaged end. First, the new section and the broken end of the pinion shaft were machined back to form a beveled joint. A 4-in. hole was then cut in the centers of both sections and a plug inserted for alignment purposes. Reinforcement bars were tack-welded across the joint to maintain alignment while the parts were placed in a rotating positioner. The reinforcement bars were then cut off and the joint was preheated to 700 degrees Fahrenheit with oxy-acetylene flame-heating heads. A UNIONMELT DS welding head was used to deposit over 275 lb. of weld metal in the vee making a sound, porosity-free joint. The welding was completed by making a surfacing weld over the entire weld area. The shaft was then machined and put back into operation at a fraction of the cost of a new part.

Call your nearest LINDE Office today and find out how you can cut costs and save time in your plant maintenance operations with UNIONMELT welding.





(Top) The two sections of the shaft are assembled on a 4-in. plug and held rigidly by temporary tie-bars. (Below) The welding is completed by making a surfacing weld over the entire length.

Shot holes are made with a powder-lance in ¼ the time needed by previous methods.

SLAG POCKET SHOT HOLES PRODUCED IN ¼ THE TIME WITH POWDER-LANCING

Before an open hearth furnace can be rebuilt the slag pocket contents and brickwork have to be blasted loose. This practice requires the making of shot holes in which the charges are placed. In the past these shot holes were produced by drilling with wagon drills, hand operated pneumatic drills, or sometimes by using hollow refractory sections . . . all costly and time consuming methods. LINDE engineers recommended powder-lancing using a mixture of aluminum and iron powder to create the extremely hot exothermic reaction needed to pierce the firebrick, slag, and hard inclusions. Producing six shot holes in a 250-ton capacity furnace by mechanical means requires up to 24 hours of drilling. With powder-lancing the job can be completed in 6 hours—only ¼ the time. The holes can be lanced at any time during the furnace production cycle because the powder-lanced holes retain their shape and size for weeks.

Call your nearest LINDE office today and find out how powder-lancing can be used to cut your open hearth furnace production and maintenance costs.

POWDER STARTING BOOSTS PRODUCTION, LOWERS COST

Powder-starting upped production 40% and cut costs 30% in this billet cut-off operation.

A southern manufacturer of steel products reports a production increase of 40 per cent and a reduction in total unit cost of 30 per cent with the introduction of powder-starting in an oxy-acetylene cut-off operation. It was estimated that a standard cutting blowpipe required a minimum of 18 seconds to start cuts in 6-in. steel gothic squares. Powder-starting was added by attaching a powder-cutting adapter to the standard oxy-acetylene cutting blowpipe. Now, cuts are started in 1½ to 3 seconds.

In powder-cutting an iron-rich powder is added to the oxygen stream to develop an extremely hot cutting flame. The powder-cutting process makes the cutting of stainless steels, cast iron, or non-ferrous metals an efficient, economical operation.

Ask your nearest LINDE representative how you can increase production and lower costs with powder-starting and other powder-cutting processes.

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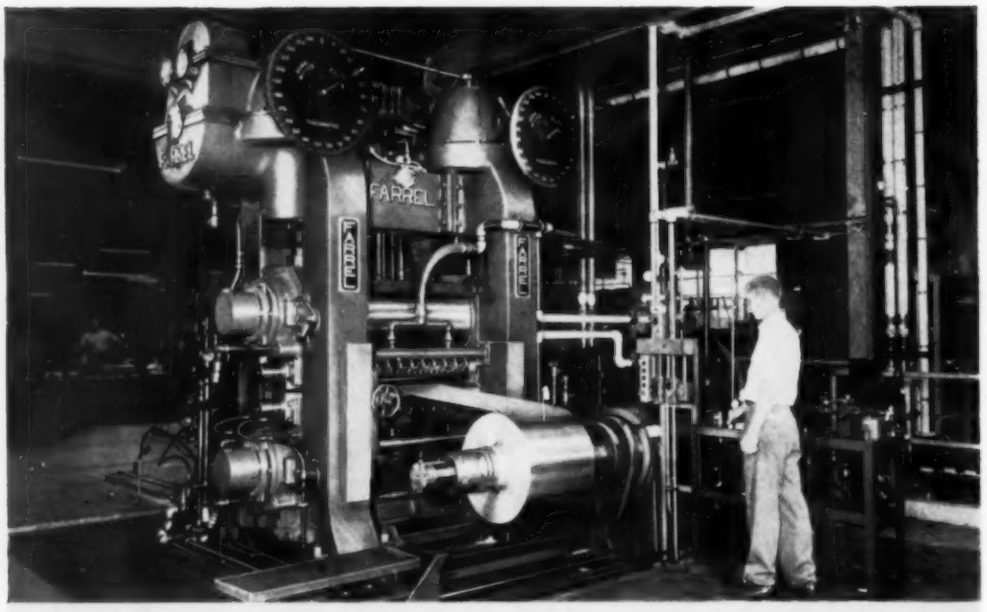
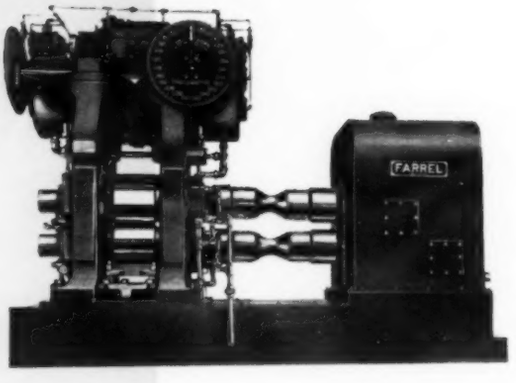
MEET THREE SOLUTIONS
to specific production problems



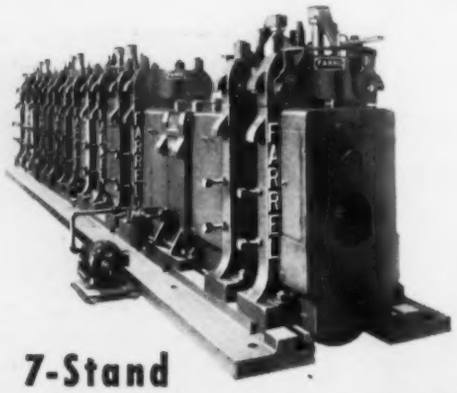
4-High Aluminum Foil Mill

Designed specifically for increasing aluminum foil production, this mill has 9" x 46" work rolls and 21" backup rolls. The speed of mill operation can be varied to meet production requirements by means of an adjustable-voltage control system.



High Carbon Cold Strip Mill

10" x 10" mill specially designed for close gauge control in continuous high-speed, cold rolling of high-carbon strip steel.



7-Stand Hot Copper Rod Mill

Seven-stand, two-high (nominally three-high) hot copper rod mill finishing train, with three low stands for handling ovals, and four high stands for handling squares.

Each mill illustrated here was designed by us with the particular requirements of the individual customer in mind. Each provided an efficient, economical solution to a specific production problem.

A Farrel® mill designed to meet *your* exact needs could be equally advantageous. Just give us your requirements, or, if you prefer, one of our engineers will be glad to discuss your problems with you.

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Patent Reviews

By MELVIN NORD, Patent Attorney, Detroit, Mich.

. . . . Copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period November 30, 1954 through December 21, 1954 . . . .

APPARATUS FOR USE IN OPENING BALES OF SCRAP METAL

▲ U.S. 2,696,352, issued December 7, 1954 to Matt Bozichovich (Campbell, Ohio), describes a simple apparatus for opening bales of scrap metal to permit examination of their contents, in order to be certain that they contain only ferrous metal.

The apparatus is shown in Figures 1 and 2. It consists of a base plate 1 of heavy metal construction similar to that employed in the steel industry for bed plates for annealing boxes. A number of wedging elements of hardy pins 2 of several different lengths are mounted on the surface of the plate, randomly arranged as to length, and in staggered rows. Each pin is provided at its base with an annular flange 10 welded to the pin, with a

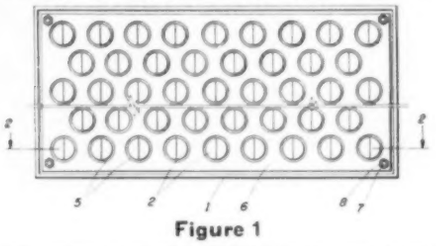


Figure 1

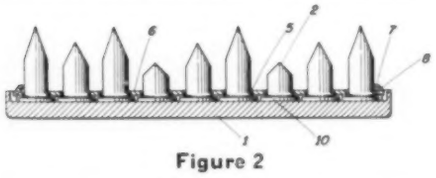


Figure 2

cover plate 6 holding the pins in position.

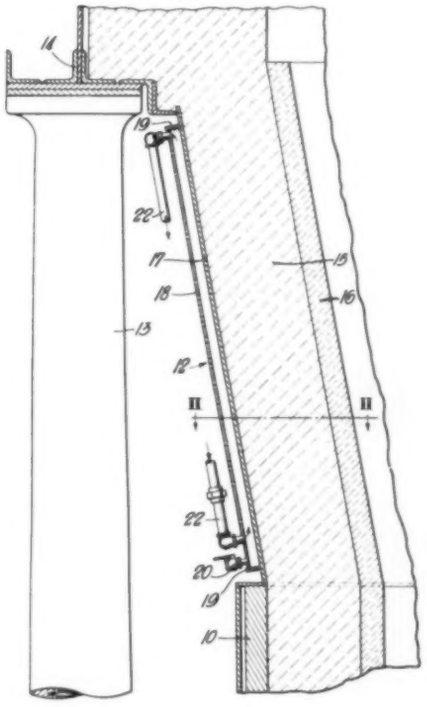
The pins are made from round bar stock of steel, about 6 in. in diameter, with a base plate about ten ft square, and with about 60 to 70 pins. One-third of the pins are 9 in. long, one-third 14 in. long, and one-third 18 in. long. For opening a bale of scrap metal, the apparatus is placed on the ground, the bale to be opened is elevated by a lifting magnet to a height of about 80-90 ft directly above the pins and then released and allowed to fall on the pins. The pins, by the wedging action of their ends, impale the bale, tend to separate its component parts from each other and sometimes disperse them sufficiently on a single drop to permit adequate inspection to be made. Generally, however, a bale of scrap metal must be lifted and dropped on the pins several times.

COOLING MEANS FOR BLAST FURNACE WALLS

U.S. 2,697,598, issued December 21, 1954 to David C. Affleck, and assigned to United States Steel Corp., describes a means for cooling blast furnace walls in the bosh region.

As shown in Figures 3 and 4, a water and gas tight metal jacket 17 surrounds the outside of the carbon blocks 15 of the wall. This jacket is

Figure 3



formed of separate sections welded together along their upright seams. A number of fully enclosed water circulation channels 18 are fixed to the outside of the jacket sections, the lower portion of each jacket having a drain cock 20 for removing sediment.

As indicated in Figure 5, successive groups of four channels each form separate water courses. A water inlet pipe 21 is joined to the lower end of the first channel of each course. Connecting pipes 22 extend from the upper end of each of the first three channels to the lower end of the next

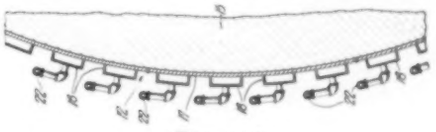
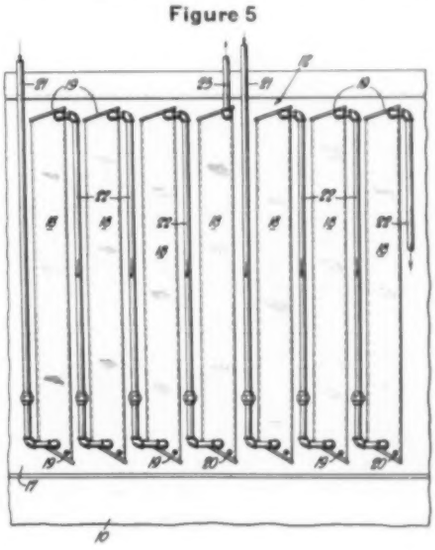


Figure 4

channel, and thus connect the four channels in series. A discharge pipe 23 is joined to the upper end of the last channel of each course.

Each water course occupies only a small portion of the wall, there being about 18 separate water courses. Therefore, if there is a temporary stoppage in the water circulation of

Figure 5



one of them, the remaining one will furnish sufficient cooling to prevent the wall from overheating.

METHOD OF SINTERING IRON ORE

Finely divided ore may be sintered into strong, porous compacts without undue fusion by a method and apparatus described in U.S. 2,696,432. The patent was issued to Edward W. Davis, on December 7, 1954, and assigned to the Regents of the University of Minnesota.

A small amount (1 to 3 per cent) of finely divided carbon is mixed with the ore before formation of the compacts. At the temperatures attained in the process (generally between 1000 and 1300 C), the carbon burns, forming the principal source of available heat supply. Additional heat is also supplied by the combustion of a gaseous fuel in contact with the incandescent solid compacts. The carbon and the gaseous fuel burn slowly and evenly without flame propagation. As a result, the agglomerates are uniformly subjected to a controlled temperature slightly but distinctly below that of fusion.

HEATING STEEL BILLETS FOR FORGING OR EXTRUSION

In U.S. 2,696,378, issued December 7, 1954 to Andrew F. Kritscher, and assigned to United States Steel Corp., a method of rapid heating of billets preparatory to forging or extrusion is described, which minimizes the formation of scale.

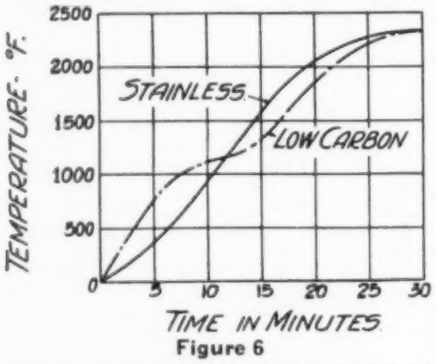


Figure 6

The method is based on the fact that low-carbon steel has a substantial short-time tensile at elevated temperatures, i.e. about 2500 psi at 2000 ' and 1500 psi at 2300 F. A steel stud is welded to one end of the billet, and is used to support the billet from overhead while it is being conveyed through a continuous, panel-type furnace which heats it rapidly to extrusion or forging temperature. After heating, and while still suspended by the stud, the billet is subjected to a descaling treatment, and it is then immersed in a fused salt bath heated to the desired final temperature of the billet. Finally after the billet is removed from the bath, the stud is sheared off, and the billet is then delivered immediately to the extrusion press.

The studs will carry the load for 30 minutes. The time required for heating the billets by the method described is shown in Figure 6, for both stainless steel and carbon steel. The scale formed in this short time is light and flaky, and can be thoroughly removed, thus saving die wear and insuring a good surface on the finished product. In addition, this permits a 10 to 15 per cent reduction in the power requirement for extrusion.

Figures 7, 8, and 9 show a galvanizing apparatus which includes a carriage 10 and a trolley 12 supporting the carriage and riding on an inclined track 13. Cables 14 are connected to the trolley and to winches for moving the carriage up the track and for controlling its downward movement. The

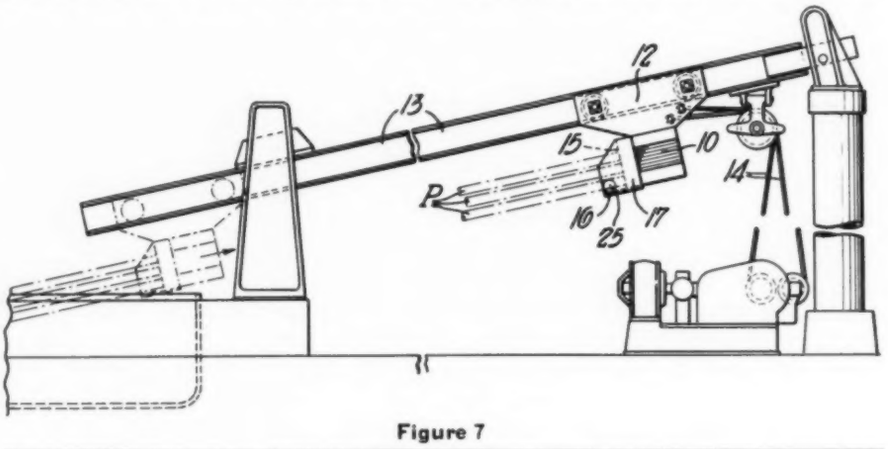


Figure 7

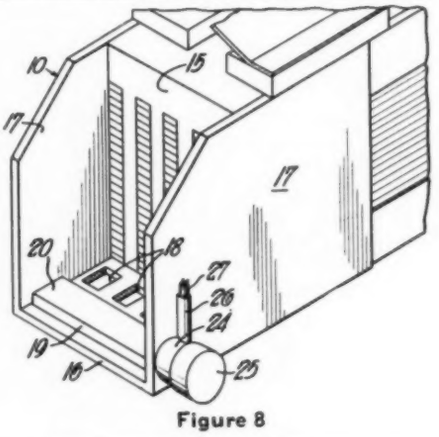


Figure 8

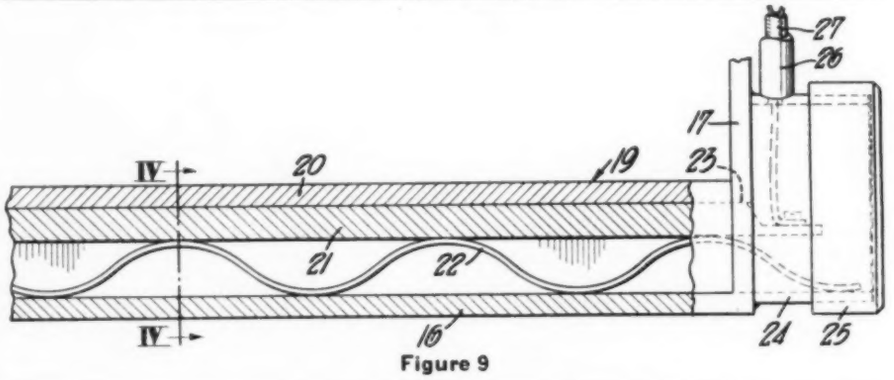


Figure 9

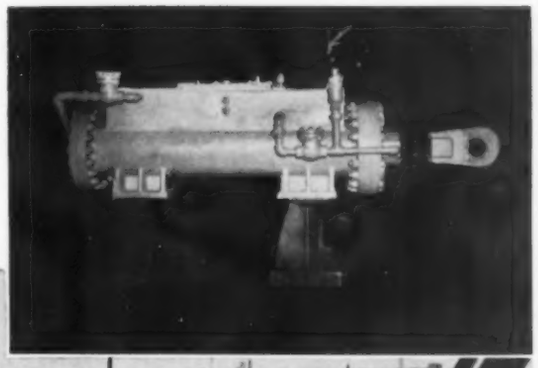
CARRIAGE FOR REMOVING PIPES FROM A GALVANIZING BATH

U.S. 2,695,594, issued November 30, 1954 to A. J. B. Fairburn, and assigned to United States Steel Corp., describes a magnetic carriage for removing pipes from a galvanizing bath, which is so designed as to prevent formation of solid zinc slugs on the pipe surface.

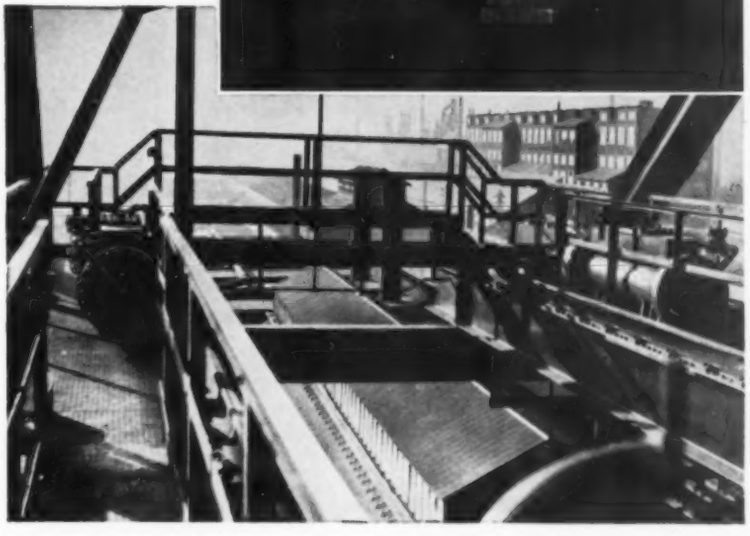
carriage contains electromagnets, the poles of which are located in face 15. A bottom guide plate 16 and a pair of side guide plates 17 extend rearward from this face. The carriage may be lowered into a galvanizing bath to pick up a number of freshly galvanized pipes P. The ends of the articles are held against the face 15 of the carriage by magnetic attraction and are confined within the space

Now — DRAVO HYDRAULIC BUFFERS give safe stops on equipment runways

New hydraulic buffers, assuring positive, safe deceleration for all types of traveling equipment, have been developed by Dravo Corporation. In the event of braking failures due to mechanical or electrical reasons, or slippery rails caused by bad weather, the hydraulic buffer acts as an auxiliary brake and eliminates the possibility of severe damage to personnel and equipment plus the resulting repair costs and plant tie-ups.



the DRAVO six-foot-stroke Hydraulic Buffer →



An eastern steel producer installed this pull-type buffer on a 15-ton ore bridge where the 215,000-lb (loaded) man trolley has a top speed of 900 fpm. The trolley strikes a buffer beam connected to the twin buffers and is brought safely and smoothly to a complete stop within six feet. The buffers reset automatically when the trolley travel is reversed.

the DRAVO two-foot-stroke Hydraulic Buffer →

A midwest steel producer needed a smaller, lighter buffer because of space and weight considerations. Dravo designed a two-foot, push-type, direct-contact buffer to meet the requirements of this installation and to produce a safe, although more sudden, stop. A spring reset is used on this buffer.

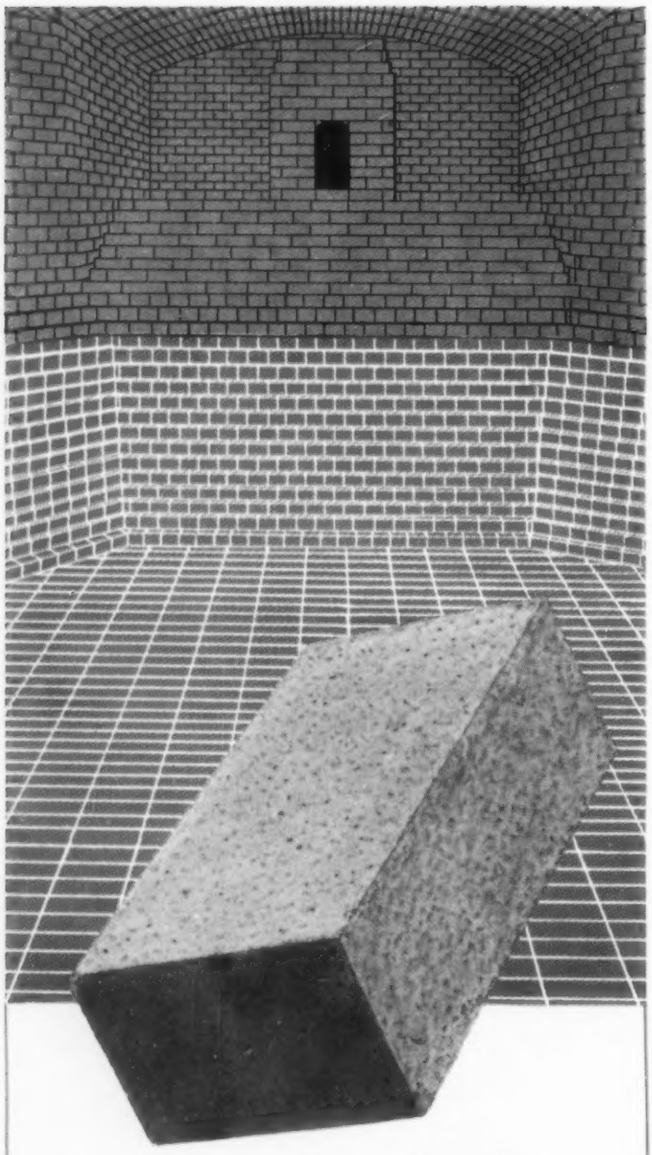
If your operations are subject to costly accidents due to the need for safe stops of traveling equipment such as man trolleys, overhead cranes, cars, etc., get in touch with Dravo for complete information on the new hydraulic buffers.

DRAVO
CORPORATION
Neville Island, Pittsburgh 25, Penna.

You get these 8 points of

SUPERIORITY

with Permanente Periclase D-S Brick



Permanente PERICLASE Brick for the Steel Industry:

Periclase "D-S" burned brick for open hearth and electric furnace bottoms. Low in iron, lime and silica. Chrome free. Maximum MgO in bottom.

Periclase-Chrome "A," plain and metal-encased for open hearth end walls, front walls and uptakes. Metal-encased for electric furnace sidewalls. High in MgO. Outstanding all-purpose refractory.

Chrome-Periclase "A," plain and metal-encased for open hearth back walls, front walls.

1. **High MgO**
2. **Chromite-free**
3. **Low iron-oxide**
4. **Low calcium oxide**
5. **Maximum density; low permeability**
6. **Slag resistance**
7. **Great volume stability**
8. **Clean edges; accurate dimensions**

All of these eight properties—outlined by major steel company ceramists as most desirable for sub-hearth brick—are found in Permanente Periclase D-S Brick.

This superior brick has been *designed especially* to withstand sub-hearth conditions—thus gives maximum protection against costly breakthroughs, gives longer sub-hearth life.

High MgO (more than 95%) is achieved through the use of pre-shrunk, accurately-sized Periclase grains derived from sea-water magnesia. Absence of chromite eliminates the reduction of chromium oxide when the sub-hearth may be in contact with the bath or when carbon monoxide penetrates to the sub-hearth.

Low iron oxide minimizes refractory damage through alternate oxidation and reduction of iron oxide and other iron compounds. Low calcium prevents damage caused by slaking during slow heat-ups or while furnace is idle.

With all its many advantages, Permanente Periclase D-S Brick gives you the ultimate in sub-hearth safety and durability—*yet costs no more!*

Call or write Kaiser Chemicals Division, *Kaiser Aluminum & Chemical Sales, Inc. Regional Sales Offices: 1924 Broadway,* OAKLAND *12, California . . . First National Tower,* AKRON *8, Ohio . . . 518 Calumet Bldg., 5231 Hohman Avenue, Hammond, Indiana* (CHICAGO).

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Pioneers in Modern Basic Refractories

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bounded by the guide plates 16 and 17. The bottom guide plate 16 contains drainage holes 18 for molten zinc which drips from the articles.

The upper face of the bottom guide plate 16 carries an electric heater 19 which extends between the two side guide plates 17. Figure 9 shows the heater. A liquid-tight steel cover 20 is welded to the bottom and side guide plates. Within the cover there is an elongated electric heating element 21 and a spring 22 which holds it in direct contact with the underside of the cover. One of the side guide plates 17 contains an access opening 23 and its outer face carries an annular boss 24 surrounding the opening. Both the heating element 21 and spring 22 extend into the boss. A pipe cap 25 closes the end of the boss. A conduit 26 from one side of the boss contains electric leads 27 for energizing the heating element.

In the absence of a heater such as the invention affords, the end portions of the lower tier of pipes P rest directly on the bottom guide plate 16, which is relatively cold. The guide plate thus chills the portions of the articles resting on it and causes the zinc coating to solidify nonuniformly and form objectionable slugs on the article surface. These slugs appear on both the inside and outside, but can be removed only from the outside. According to the present invention, the end portions of the lower tier of pipes rest on the heater 19, which maintains their temperature and thus prevents slug formation.

SUPPORTING CAR FOR A BESSEMER CONVERTER

U.S. 2,696,663, issued December 14, 1954 to Wilbert H. Wright and Anthony B. Cavalle, and assigned to National Steel Corp., describes a converter car for use in a converter plant to facilitate relining and repairing a converter. When one of the converters at a blowing station becomes eroded and must be relined with refractory material, this converter is removed from its fixed supports and placed on the converter car at the relining station. A spare converter is removed from the relining station and is exchanged for the converter being removed. Thus, full production can be maintained at all times. The patent describes a building to be used for this purpose, as well as the converter car.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,695,515	11/30/54	Tin plate testing	Bethlehem Steel Co.
2,695,872	11/30/54	Electrolytic polishing method	Armco Steel Corp.
2,696,131	12/ 7/54	Vertical rolling mill	Birdsboro Steel Foundry and Machine Co.
2,696,279	12/ 7/54	Steel door construction	Republic Steel Corp.
2,696,450	12/ 7/54	Austenitic alloy steel	Allegheny Ludlum Steel Corp.
2,696,646	12/14/54	Semicontinuous casting of ingots	Loma Machine Mfg. Co., Inc.
2,697,335	12/21/54	Rolling mill spindle and coupling	Birdsboro Steel Foundry and Machine Co.
2,697,596	12/21/54	Magnetic brake for quenching apparatus	Loftus Engineering Corp.

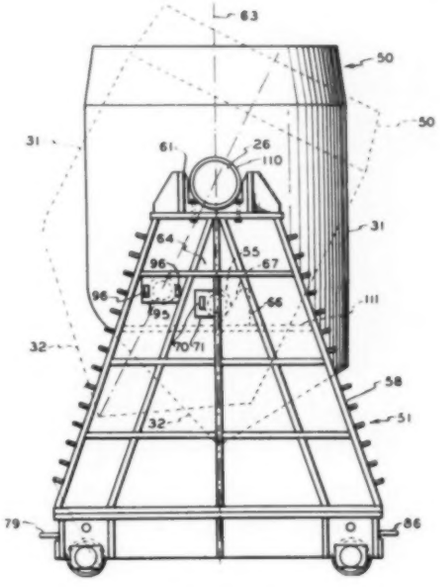


Figure 10

The converter car is shown in Figure 10, and the building in Figure 11. The car is designed so as to facilitate rotation and inversion of the converter when it is at the relining station 22. Debris drops into the pit 72 out of the way. The building 98 is designed so as to facilitate relining the converter.

RECIRCULATION OF WASTE PICKLE LIQUOR

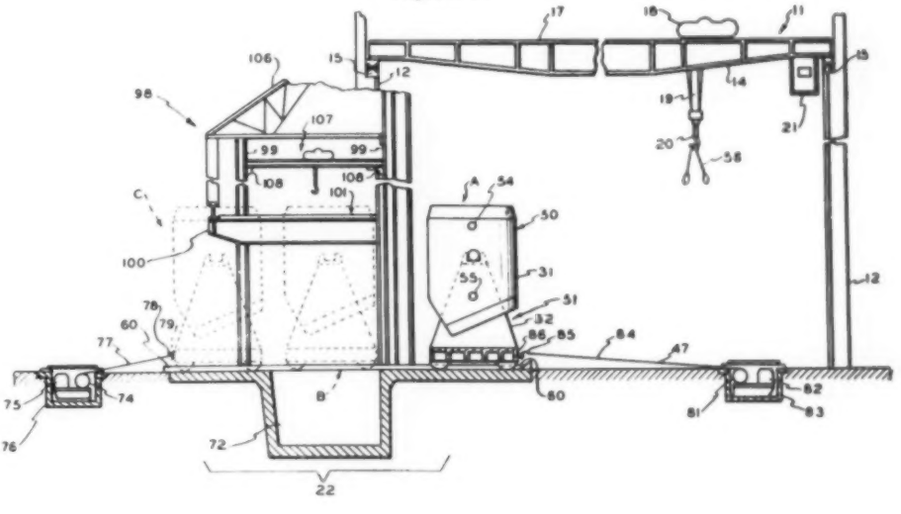
U.S. 2,697,050, issued December 14, 1954 to Roger R. Barnes, and assigned to Bethlehem Steel Co., describes apparatus for pickling strip metal in which the metal moves continuously through the pickling apparatus while the pickling solution is being continuously recirculated.

The distinctive feature of the invention is that rapid mixing and stability of the entire pickling operation are obtained without regenerating any of the solution. This is accomplished by continuous withdrawal of part of the pickling liquor and replacement with fresh acid.

MOVABLE WATER-SPRAY SYSTEM FOR ROLLING MILL RUN-OUT TABLES

U.S. 2,696,823, issued December 14, 1954 to Howard Scott (Dravosburg, Pa.), describes a water spray system for the run-out table of a continuous strip mill which may be easily and speedily moved out of operating position to safeguard against damage from strip accumulating on the run-out table due to an interruption in the operation of the table.

Figure 11



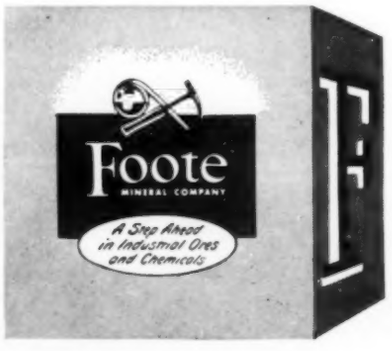
Better steels are the result of many things, not the least of which are addition agents. Although they may be small quantitatively, additives are extremely important qualitatively.

For many years, Foote Mineral Company has aided steel makers in materially improving both the quality of finished steel and the intermediate conditions involved in producing it. Manganese Sulphide and Rimex are two steel additives developed by Foote. Manganese Sulphide, for instance, provides a more practical and economical means of introducing manganese and sulphur into free-machining steels. Rimex, by producing a more vigorous rimming action, improves the quality of rim steels while reducing production costs.

Foote's highly specialized metallurgical engineering group is eager to work with steel producers to find means to improve both the economies and characteristics of metals for industry.

Write for information.

Product data sheets will be sent upon request.



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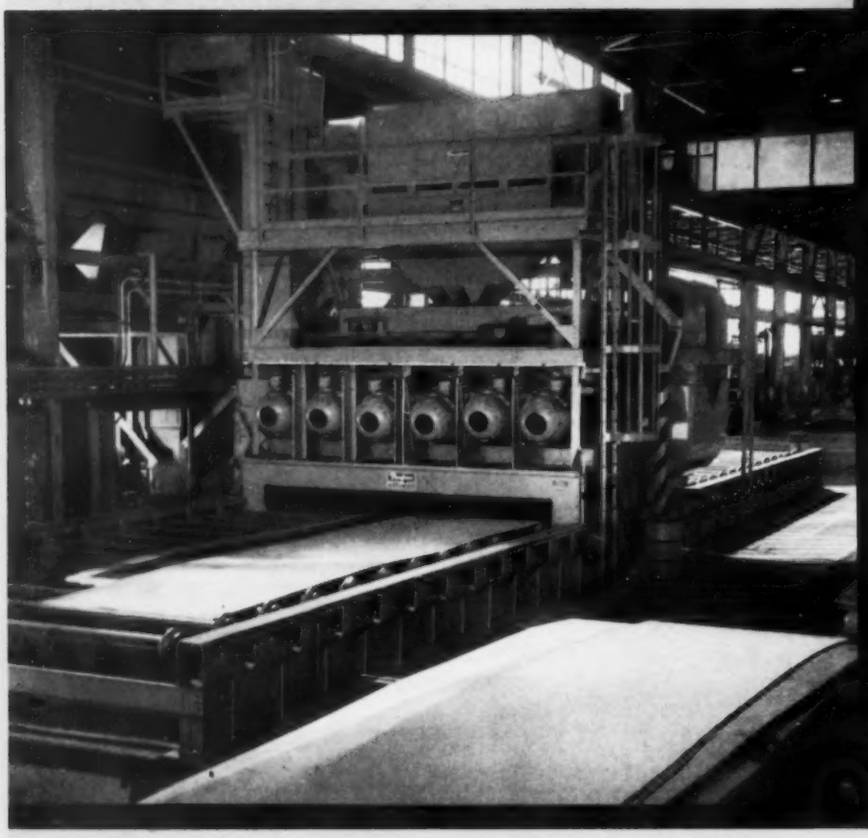
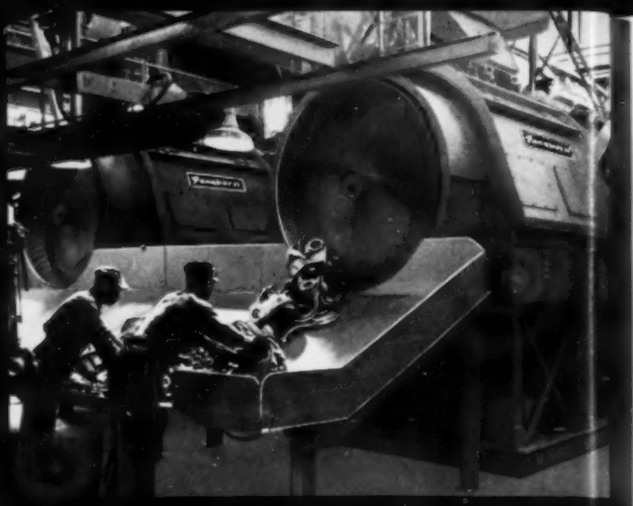
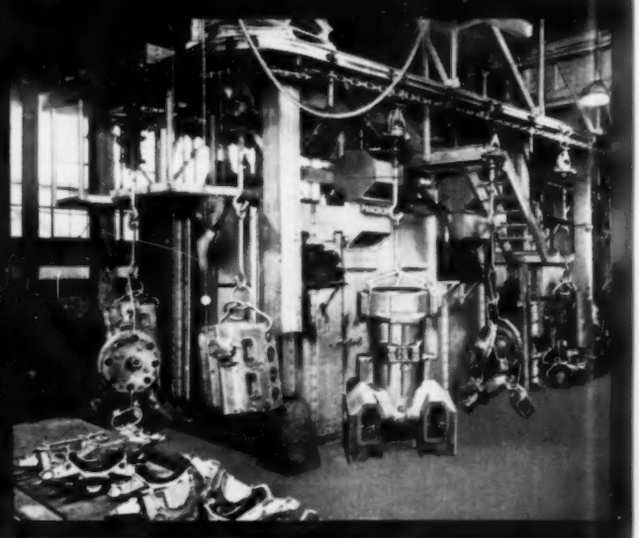
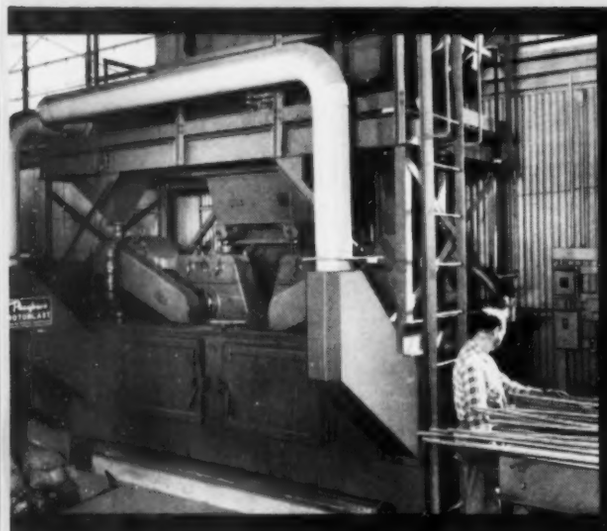






an unusual blast cleaning problem,



If you are a company with a special cleaning problem, Pangborn offers you a special service—a machine designed for your individual needs. It might be a descaling machine for bars, sheets and coils, a continuous-flow barrel or a monorail cabinet like the machines shown here . . . or it might be completely different. You may need to clean cylinder blocks, bathtubs or any unusual ferrous or nonferrous castings, forgings, stampings. If so, Pangborn engineers will study your problem and its relation to your production line. Then they'll design a Pangborn machine that gives you better cleaning and faster production at lower cost. Pangborn has proved it in hundreds of cases. Pangborn can prove it to you! Write today for Bulletin 1210 to: PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning and Dust Control Equipment.*

*U. S. Pat. #2184926 (other patents pending)

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Special Blast Rooms & Cabinets

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you can double the life of your peels with UNIVAN castings

On record are cases where UNIVAN peels are lasting two to three times the life of carbon peels . . . and in some cases even longer. For UNIVAN steel, compared with carbon steel, has greater resistance to firecracking and greater resistance to torsional twist and shock.

When you consider what this longer life can mean to you in terms of fewer castings, less machining (the cost of machining may equal the original cost of the casting), and less downtime . . . the net result could be more than a 50% saving.

So check the life of your peels. And if you're not satisfied, give UNIVAN peels a chance to prove how they can perform on your toughest jobs. Likewise, for your charging boxes, bearing covers, couplings and spindles, tongs and levers . . . as all of them are available in this special alloy steel.

Write us for complete information. Or send your blueprints for a prompt quotation on your requirements . . . for castings in the rough or completely machined.

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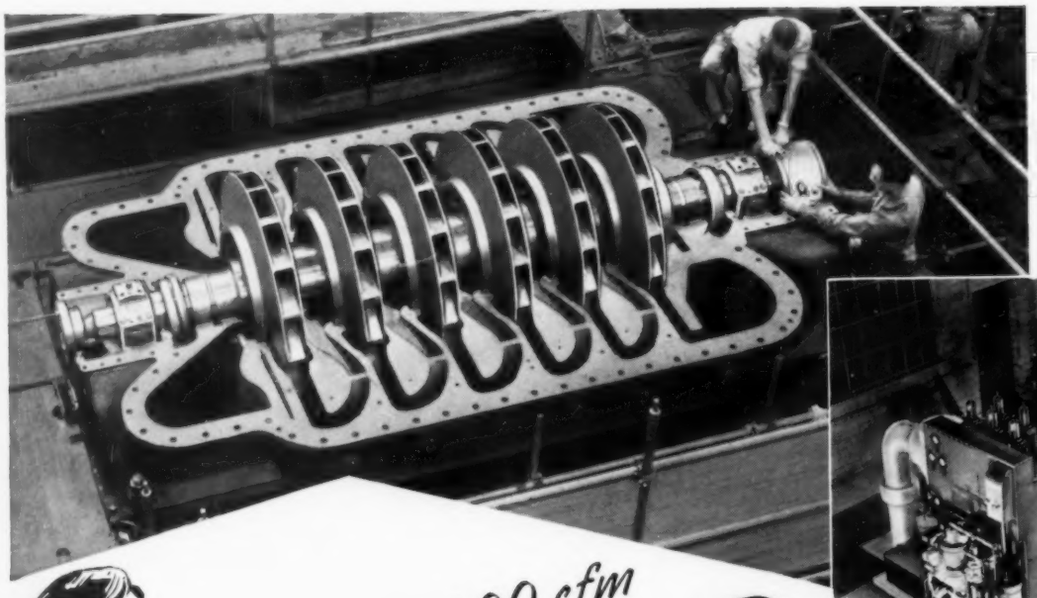
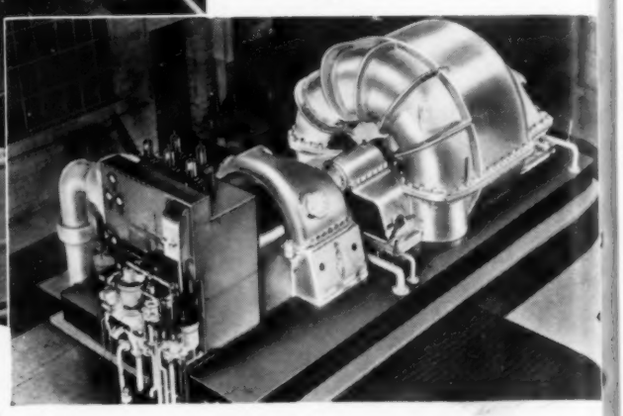
UNION PRODUCTS: charging boxes • peels • bearing covers • slag pots • tongs and tong levers • universal couplings and spindles • gears and pinions • ingot cars • charging box cars • special UNIVAN and ARMOR steel castings

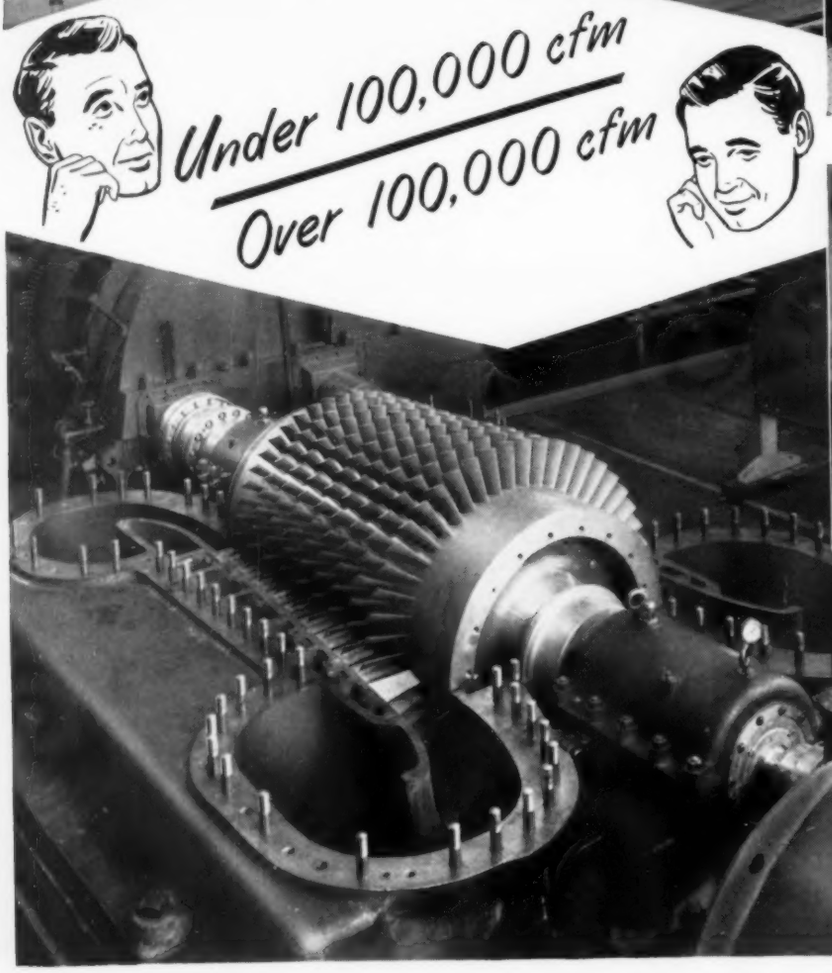
What type BLOWER

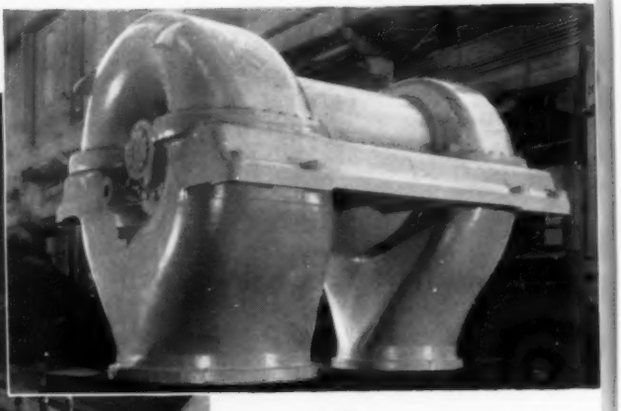


Typical centrifugal blower with upper half of casing removed.

75,000-cfm, 30-psig blast furnace blower.







Typical axial compressor of blast furnace size.

Blast furnace type axial compressor with upper half of casing removed.

ALLIS-

for your steel mill?

As requirements move above 100,000 cfm, axial compressor may replace centrifugal blower because of higher efficiency and lower operating cost. Allis-Chalmers experience with both types assures you of sound recommendations.

Battling rising costs, blast furnace designers have sought increased economy through larger blast furnaces. Air requirements of the new units have risen rapidly and have now reached the point where the centrifugal blower is not always the most efficient and economical unit. These are some of the design and operating factors that influence the choice of the best blower for the job:

EFFICIENCY — The axial compressor is inherently more efficient than the centrifugal blower. This is due largely to the fact that the air passing through the centrifugal blower follows a complicated air path, with sharp turns passing from one stage to the next. In an axial compressor, the air path is more nearly a straight line and losses from sharp turns in the air path are avoided.

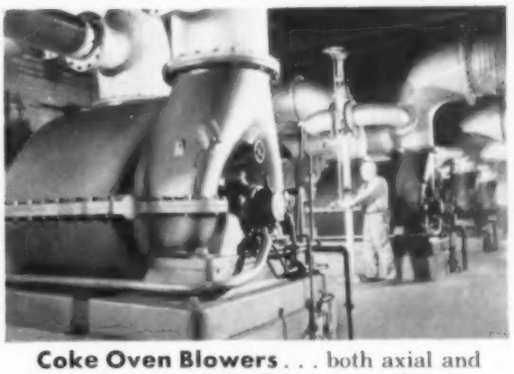
DRIVE UNIT — At 100,000 cfm and above, the speed of a centrifugal blower has dropped below 3600 rpm, while the speed of a comparable axial compressor is approaching 3600 rpm. This difference becomes more pronounced as units get larger. Since the optimum speed of either a turbine or motor drive is about 3600 rpm, the centrifugal makes best use of the drive in smaller sizes, while the axial makes best use of the drive in larger sizes.

SIZE — In all sizes the axial compressor is smaller than a centrifugal blower of the same rating. This means less floor space, smaller foundations, reduced costs.

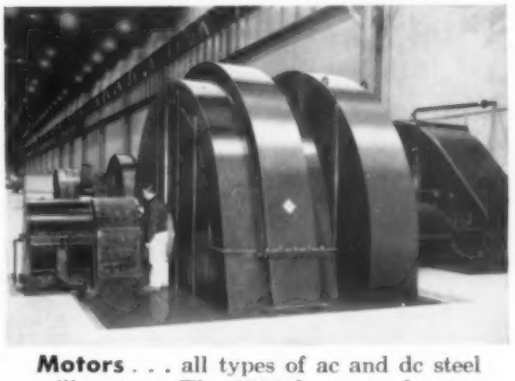
Unbiased Analysis and Recommendations

Since Allis-Chalmers has had wide experience in building both centrifugal and axial types, your Allis-Chalmers representative can help you with your blower problems. Call your nearby Allis-Chalmers District Office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

Other Allis-Chalmers Steel Mill Equipment



Coke Oven Blowers . . . both axial and centrifugal types for booster or exhauster service. Photo shows four 23,000-cfm, 5100-rpm, 35-psig exhausting blowers in western steel mill.



Motors . . . all types of ac and dc steel mill motors. The 3500-hp wound-rotor motor shown is used in conjunction with four 6000-hp synchronous motors driving roughing stands of 80-inch hot-strip mill.

Electric Power Equipment . . . steam turbine-generator units, transformers, switchgear, circuit breakers, rectifiers, control. Shown is a 33,000-kw steam turbine-generator unit with hydrogen-cooled generator supplying power in a modern eastern steel mill.

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OF HEAVY PARTS with THERMIT

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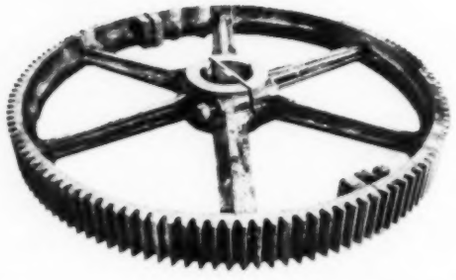
Heavy machine frame repaired by Thermit Welding.

Thermit is used extensively for pinion gear repair.



3 fractures in this large ring gear were quickly repaired by Thermit Welding.

Crankshaft, 8" in diameter, was restored to duty by Thermit after being broken.

When industrial equipment breaks down, the most important problem is to get it back in service—and FAST! Thermit Welding has answered this need time and again . . . in a variety of plants . . . for a variety of parts. Thermit requires a minimum of technical skill . . . gives consistently sound welds . . . is more economical than part replacement. Thermit repairs are permanent repairs.

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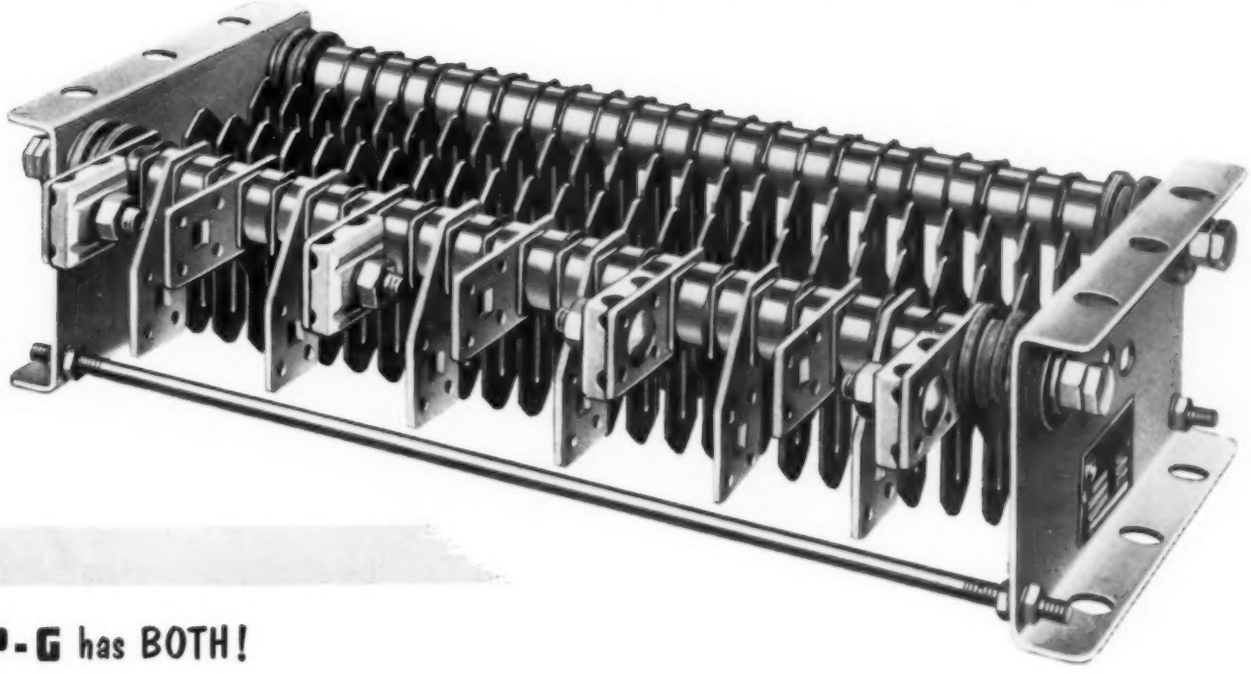
Because the resistance grids used for P-G STEEL GRID RESISTORS are produced in a great number of specific resistance values. Thus the varied current requirements for accurate motor control are easy to obtain.



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STANDARD Resistors

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The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

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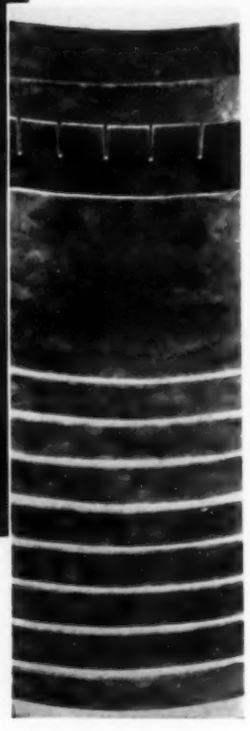
How special insulation protects

DEEP-DOWN
PULLING POWER



Stearns uses a special mica plate for insulation around the inside diameter of the coil and between the pancake coils. Mica is laminated and consists of about nine layers of 1/32 in. molding mica. This is applied under heat and provides a very dense and hard insulation between the copper and steel. Discs between coils are also made of laminated mica and finished under pressure.

• Protect the coil and you safeguard the very heart of a lifting magnet. That is why powerful, deep-field Stearns magnets are built with extra heavy-duty coil insulation, extra protection against shorts, burn-outs, current leakage.

With this insulation, a Stearns lifting magnet can withstand heat generated during steady work periods — operates profitably on long-shift duty. And it's added protection when magnet is working outdoors or under excessively damp conditions.

Superior insulation is only one of the ways Stearns keeps its powerful lifting magnets in top operating condition. See your Stearns representative for all the facts, or write for Bulletin 35-C. 1098

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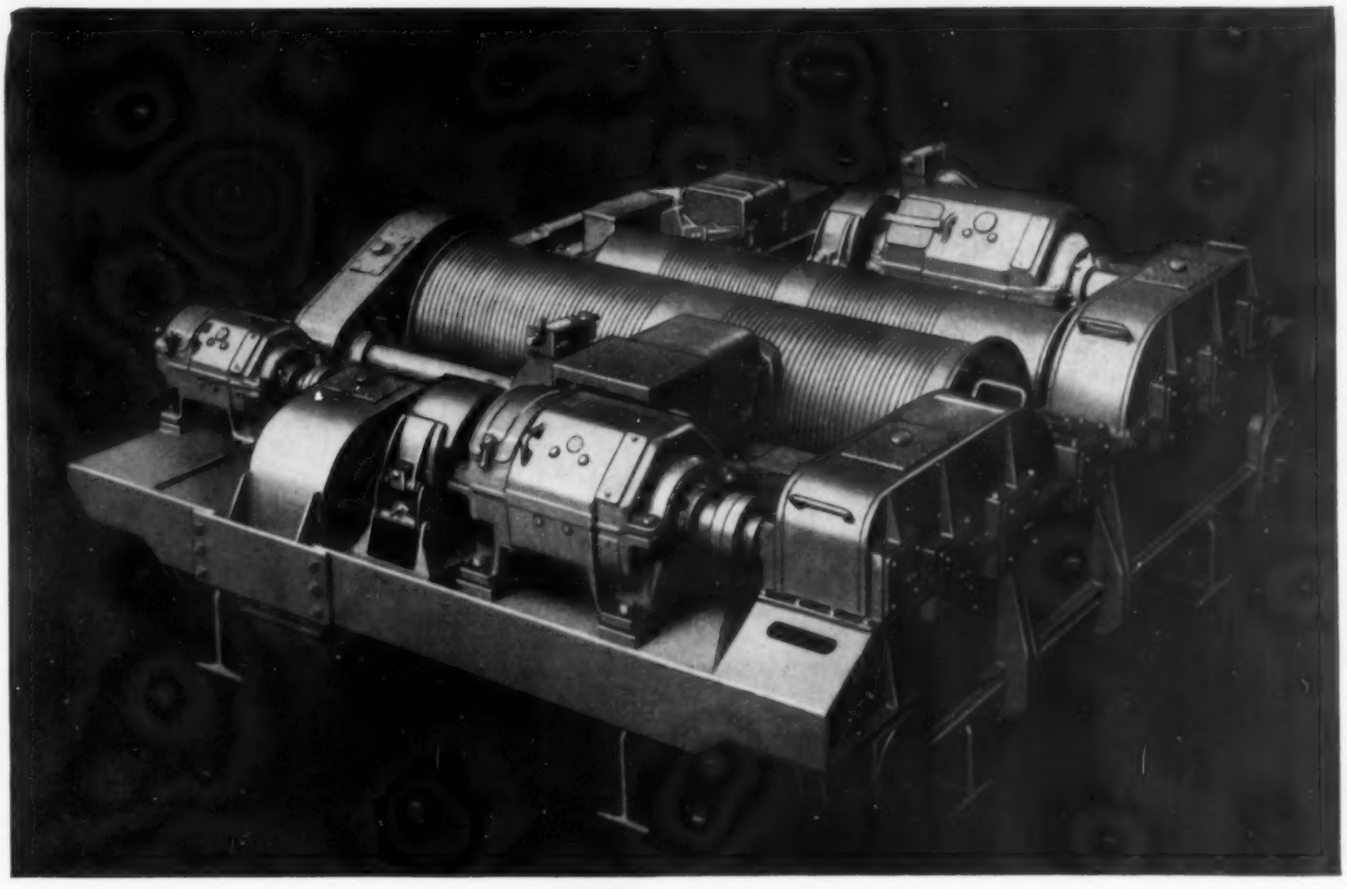

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FOR HEAVY DUTY MILL TYPE CRANES

"Simple Design is Sound Design"

We offer a complete line of trolleys built to meet the most exacting requirements. These trolleys are constructed of the finest materials available. No cast iron is used. All shafts are of highest quality alloy steel. All bearings are calculated with a proper life factor for service required as defined by the A. I. S. E. We will build a trolley to fit your special requirements as to gauge, head room, approaches and general arrangement. We also make a complete line of cranes for steel mill use. . . Your inquiries will be welcome.

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BOX 309, WILLOUGHBY (CLEVELAND), OHIO

Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

Koppers rebuilds coke ovens *from the ground up!*

BESIDES BUILDING NEW COKE OVENS, Koppers specializes in prolonging the life of old ovens. Koppers does this by repairing them, or when necessary, by rebuilding them from the ground up.

In many cases, preventive maintenance by Koppers can head off major repairs. For example, it pays to straighten buckstays and renew jamb castings *before* the heating-wall brickwork has been seriously damaged.

However, even if a battery of coke ovens has reached the advanced stages of deterioration, it can be rehabilitated by Koppers so that it will enjoy many *extra* years of productive life. When Koppers repairs coke ovens, part of the battery can be kept in operation.

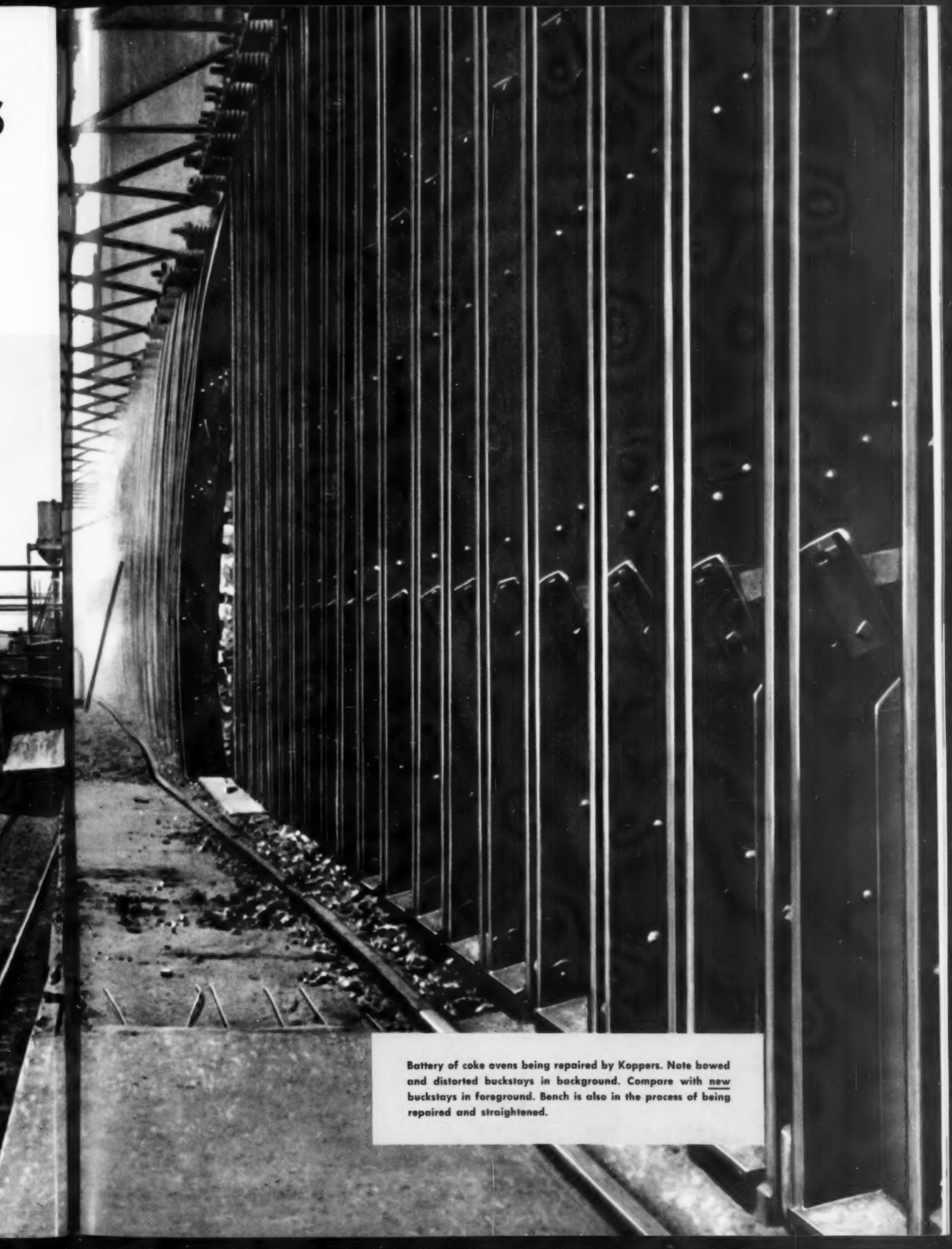
Our inspectors will be glad to examine your coke plant. Their report will be reviewed and evaluated by men who have been designing, building and repairing coke ovens for many years. Then, where necessary, recommendations for repair work will be made. Your inquiry is invited regarding this service.

Constructing, rebuilding or repairing coke ovens is just one way in which Koppers serves the steel industry. For any kind of metallurgical construction, you can count on Koppers.

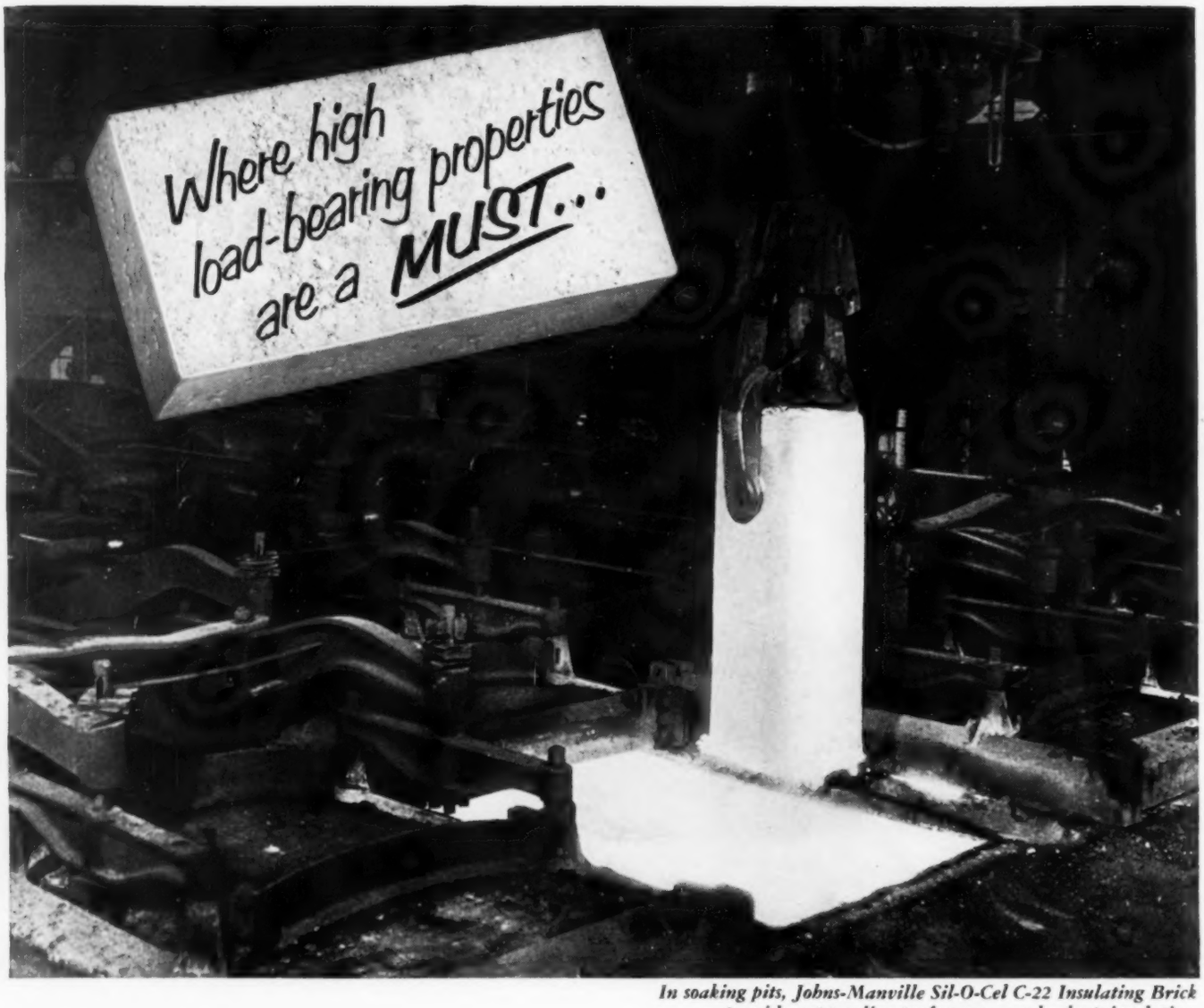
KOPPERS

Engineering and Construction Division

KOPPERS COMPANY, INC., PITTSBURGH 19, PENNSYLVANIA



Battery of coke ovens being repaired by Koppers. Note bowed and distorted buckstays in background. Compare with new buckstays in foreground. Bench is also in the process of being repaired and straightened.



In soaking pits, Johns-Manville Sil-O-Cel C-22 Insulating Brick provide outstanding performance as back-up insulation.

Specify

Johns-Manville SIL-O-CEL C-22 Insulating Brick

the diatomaceous silica brick that retains its high cold crushing strength of 700 psi throughout normal service range

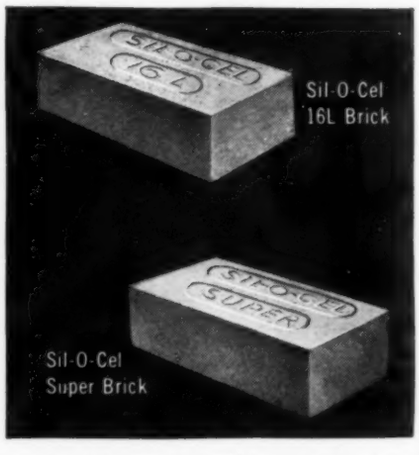
Because of its exceptional strength Sil-O-Cel C-22 Insulating Brick has gained wide acceptance as an all-purpose insulating brick. It is especially recommended for soaking pits, open hearth bottoms, slab heating furnaces, hot blast stoves, coke ovens and other high temperature equipment.

Millions of microscopic cells provide Sil-O-Cel C-22 brick with excellent heat resistance up to 2000F. It has a thermal conductivity of only 1.88 Btu in/sq ft/F/hr at 1000F mean temperature. In addition, with a density of 38 lb/cu ft, it is light and easy to handle.

For direct exposure or back-up to 1600F, use Sil-O-Cel 16L Insulating Brick. This newest member of the J-M diatomaceous silica insulating brick family has *less than 0.1% reversible thermal expansion at 1600F.* Conductivity is 1.07 Btu in/sq ft/F/hr at 1000F mean temperature with a density of 33-35 lb/cu ft. Cold crushing strength is 350 psi. Sil-O-Cel 16L serves equally well as back-up insulation or exposed refractory lining.

For back-up at higher temperatures, specify Sil-O-Cel® Super Insulating Brick with an unusually high temperature limit of 2500F.

Write today for further information on Sil-O-Cel Insulating Brick and Insulating Fire Brick. Ask for Brochure IN-115A. Address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 565 Lakeshore Road East, Port Credit, Ontario.

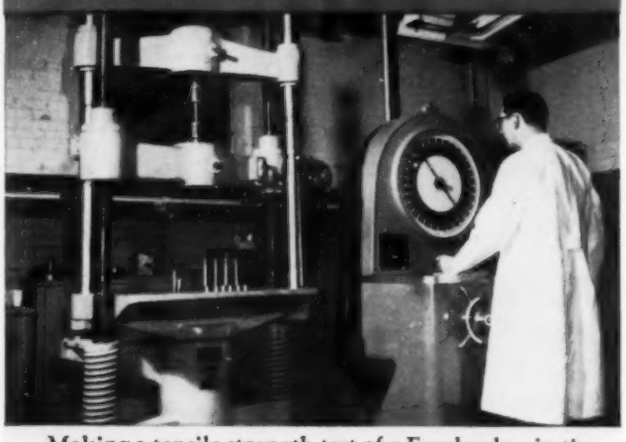


JOHNS-MANVILLE JM PRODUCTS

Johns-Manville *first-in* INSULATION

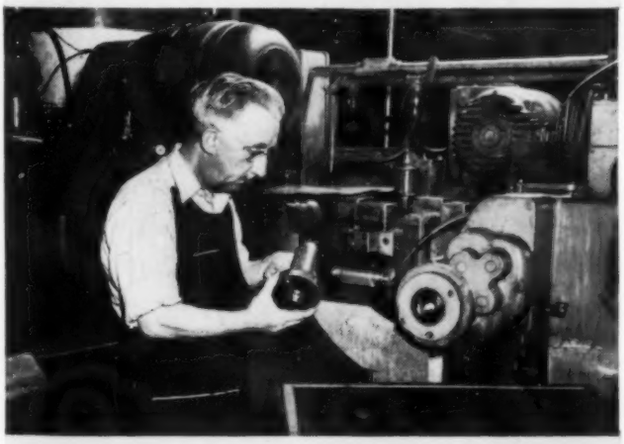
MATERIALS · ENGINEERING · APPLICATION

CROUSE-HINDS rigid quality control *assures long-lasting products ...* CONDULET* records prove it!



Making a tensile strength test of a Feraloy bar in the Mechanical Laboratory. Constant testing insures uniform quality.

A hydrostatic test of a Type EPC explosion-proof Condulet. It must withstand a pressure 4 times as great as an internal explosion.



The first CONDULETS, introduced by Crouse-Hinds in 1905, were so well designed and so carefully manufactured that many of the early installations are still in use.... still giving dependable service after more than forty years. This record proves that where quality counts, you can count on CONDULETS!

Crouse-Hinds high standard of quality has always been controlled by careful checking and testing of both raw materials and the finished product. The CONDULET line has expanded from a few items to more than 15,000 types and sizes and the testing laboratories have kept pace with this development. They contain the latest and most modern testing equipment.

Laboratory testing is only part of Crouse-Hinds system of rigid quality control. Factory inspection is equally important. Together, they assure a superior product that will serve you better . . . and last longer!

Always specify CONDULETS.

***CONDULETS are made only by CROUSE-HINDS**

CROUSE-HINDS COMPANY
Syracuse 1, N. Y.

OFFICES Amarillo — Birmingham — Boston — Buffalo — Chicago — Cincinnati — Cleveland
Dallas — Denver — Detroit — Houston — Indianapolis — Kansas City — Los Angeles — Memphis
Milwaukee New Orleans — New York — Philadelphia — Pittsburgh — Portland, Ore
San Francisco — Seattle — St. Louis — St. Paul — Tulsa — Washington
RESIDENT REPRESENTATIVES Albany — Atlanta — Baltimore — Charlotte — Chattanooga
Corpus Christi — Reading, Pa. — Richmond, Va. — Shreveport
Crouse-Hinds Company of Canada, Ltd., Toronto, Ont.

Type LB
Obround Condulet

Type EVA Explosion-Proof
Lighting Fixture

Type GUAC Explosion-Proof
Junction Condulet

Type ARE
Plug Receptacle

Type FSC Tumbler
Switch Condulet

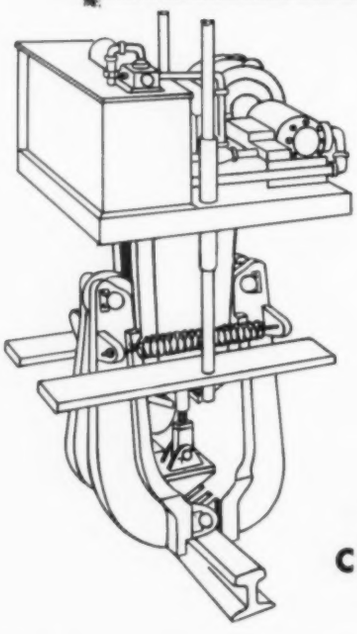
CONDULET
First in the field
STANDARD OF QUALITY

A Nationwide Distribution Through Electrical Distributors

AIRPORT LIGHTING · FLOODLIGHTS · CONDULETS · TRAFFIC SIGNALS

the utmost **SAFETY**

in the Operation of ORE and COAL BRIDGES Makes HEYL & PATTERSON Hydraulic Rail Clamps and Hydraulic Buffers a MUST!



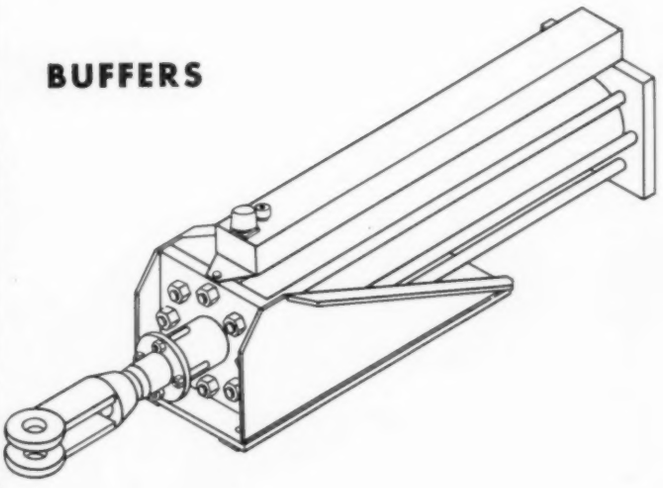
RAIL CLAMPS

If a coal or ore bridge moves due to wind or over-skews due to electrical or human failure, then safety of men and equipment depends on the rail clamps. They are designed to set automatically in case of interruption of power due to over-skew or high wind.

H & P hydraulic rail clamps afford a positive holding force on runway rails. Clamp setting time can be adjusted between 2 and 10 seconds, and units in sizes up to 75 tons each can be furnished.

Heyl & Patterson hydraulic rail clamps are available in suitable sizes to protect new or old structures.

BUFFERS



If the trolley is headed for the end of the runway, and control is lost because of electrical or mechanical failure, ice on rails, or operator incapacity, safety of men and equipment depends on the buffer. H & P hydraulic buffers afford positive controlled deceleration when all else fails.

Because this buffer is pull-type, the piston is fully protected when not in use, and a minimum of maintenance is required. A latching device on the trolley resets the H & P buffer assembly automatically.

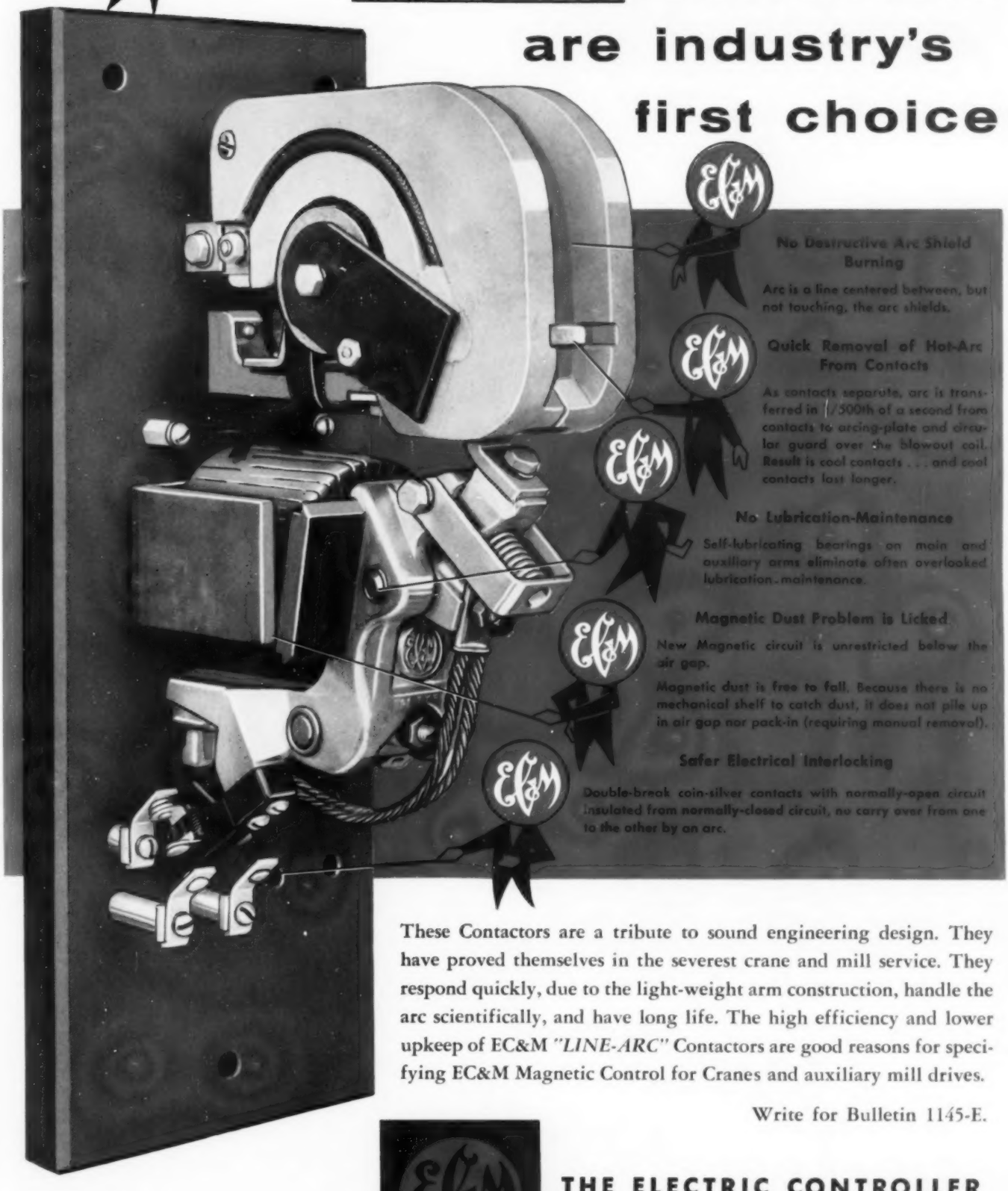
Heyl & Patterson hydraulic buffers are available in 2, 4, and 6 foot travel for both old and new installations.

Heyl & Patterson's 50 years of experience with movable structures can help you increase the safety of your equipment.

Heyl & Patterson INC.

55 FORT PITT BLVD. PITTSBURGH 22, PA. PHONE COurt 1-0750

here's why LINE-ARC contactors are industry's first choice



No Destructive Arc Shield Burning

Arc is a line centered between, but not touching, the arc shields.

Quick Removal of Hot-Arc From Contacts

As contacts separate, arc is transferred in 1/500th of a second from contacts to arcing-plate and circular guard over the blowout coil. Result is cool contacts . . . and cool contacts last longer.

No Lubrication-Maintenance

Self-lubricating bearings on main and auxiliary arms eliminate often overlooked lubrication-maintenance.

Magnetic Dust Problem is Licked

New Magnetic circuit is unrestricted below the air gap.

Magnetic dust is free to fall. Because there is no mechanical shelf to catch dust, it does not pile up in air gap nor pack-in (requiring manual removal).

Safer Electrical Interlocking

Double-break coin-silver contacts with normally-open circuit insulated from normally-closed circuit, no carry over from one to the other by an arc.

These Contactors are a tribute to sound engineering design. They have proved themselves in the severest crane and mill service. They respond quickly, due to the light-weight arm construction, handle the arc scientifically, and have long life. The high efficiency and lower upkeep of EC&M *"LINE-ARC"* Contactors are good reasons for specifying EC&M Magnetic Control for Cranes and auxiliary mill drives.

Write for Bulletin 1145-E.

THE ELECTRIC CONTROLLER & MFG. CO.

4498 LEE ROAD • CLEVELAND 28, OHIO

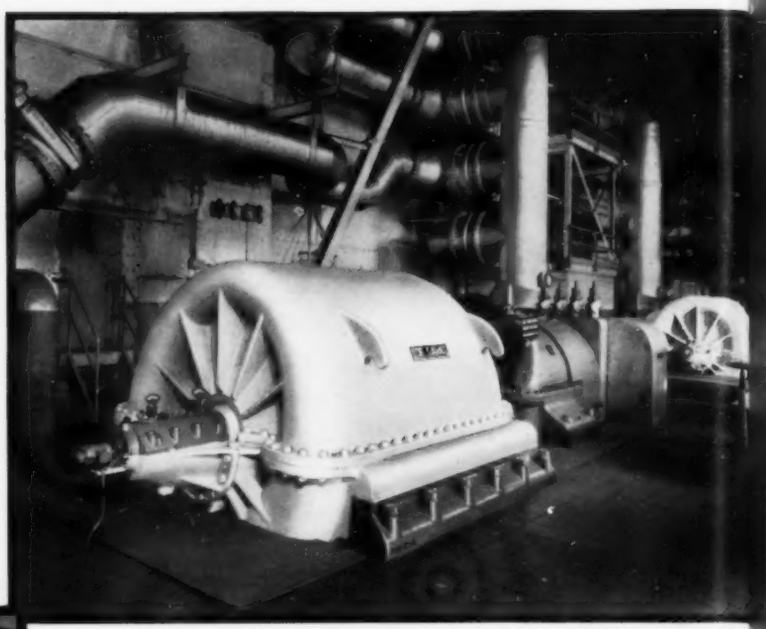
6186

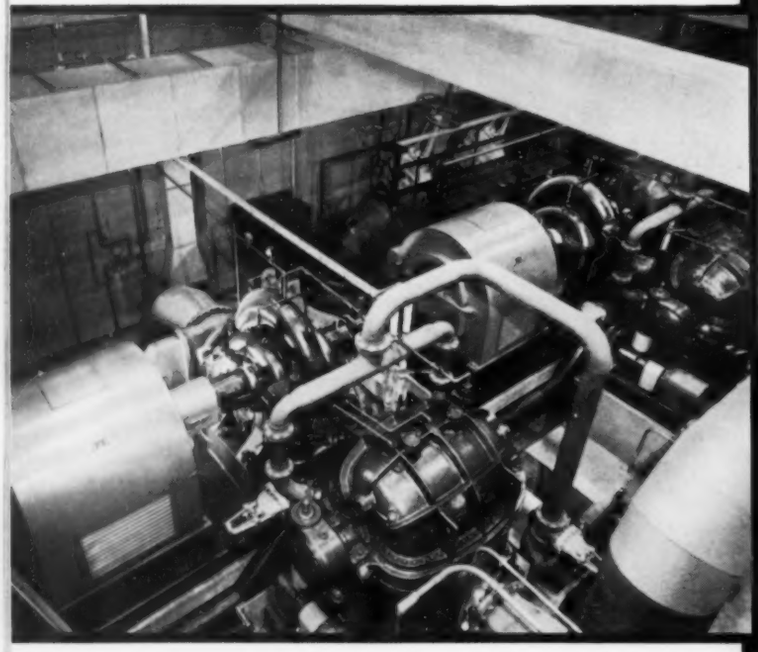
DE LAVAL
CENTRIFUGAL BLOWERS AND PUMPS

stay on the line for years at Jones & Laughlin

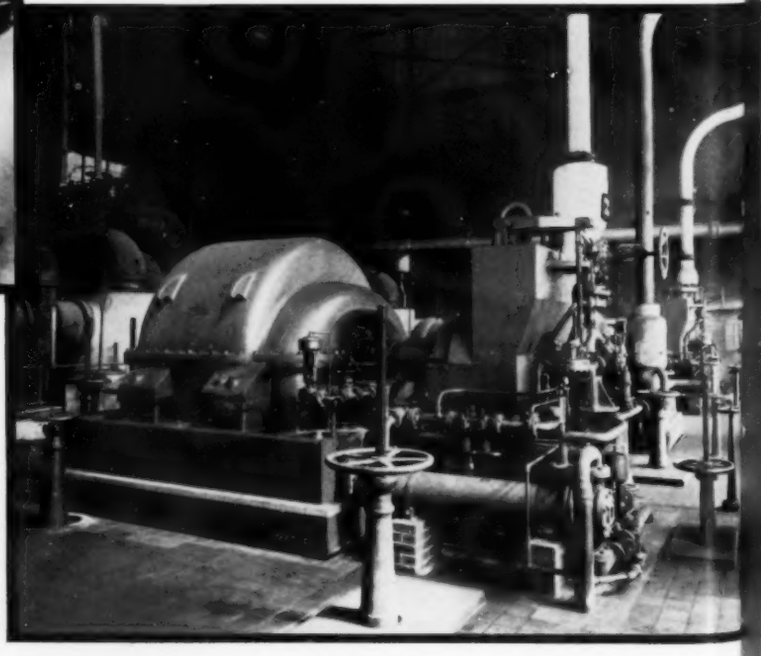
Jones & Laughlin reports: "*We have been using De Laval equipment for many years, and from our experience we have learned that De Laval blowers and pumps are inexpensive to maintain. Service is excellent. We can get spare parts quickly.*"

Three De Laval 22,000 gpm motor-driven pumps are on the job at Jones & Laughlin Steel Corporation in Pittsburgh, Pa. These units are used to pump river water to the open hearth and general mill. Installed in October 1951, these three pumps "have not had any downtime at all since their installation except for periodic inspections," Jones & Laughlin reports.





These two De Laval centrifugal blowers, each rated at 100,000 cfm, are in use 24 hours per day, seven days per week except for a yearly inspection period. Since installation, there has been only 24 hours downtime in one of these blowers with a maintenance cost of about $400. "That's very little for this type of equipment," says the Jones & Laughlin blower room foreman.



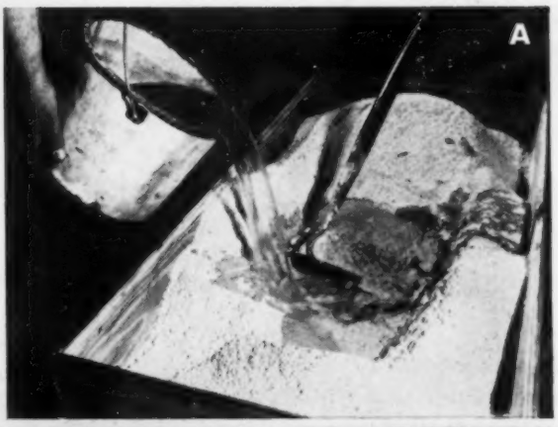
This is one of three De Laval gas exhausters, operating at 48,000 cfm around the clock. Two of these units can handle maximum capacity; the third is used as a spare. Jones & Laughlin says, "Without good gas exhausters you would have to 'bee hive' (open the top and permit the gas to go free), thus losing our by-product."

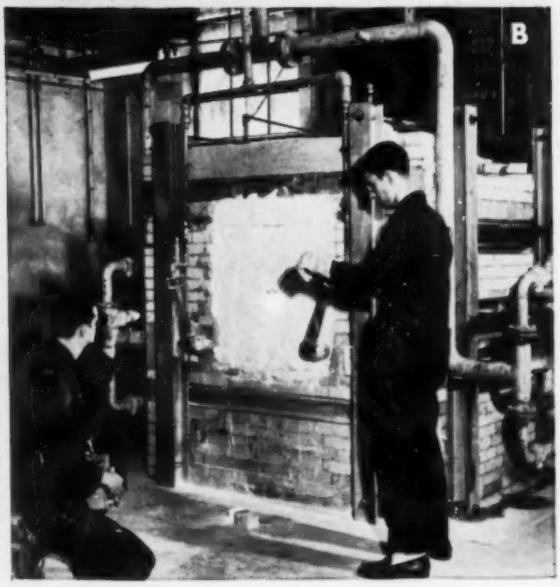
Send for Bulletin 0504

DE LAVAL *Pumps and Blowers*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

NEW B&W 3200 degree Refractory Concrete





Today, in some types of heating and melting furnaces, complete linings or sections of linings are subjected to temperatures over 3000 F and, with the trend to higher and higher operating temperatures, the problem of finding the most economical refractories for this "over 3000 F service" will become even more important.

Now, with B&W's new Refractory Castable-3200, furnace builders and operators can cut installation costs by using castable construction for services up to 3200 F. As easy to use as other B&W refractory concretes, B&W Refractory Castable-3200 can be poured or trowelled into place or applied with a cement gun.

Several years ago, B&W developed Kaocast, the first successful 3000 degree refractory concrete, to lead this high temperature castable trend. B&W Castable-3200, like Kaocast, is made with an alumina-silica base and is recommended for temperatures from 2600 to 3200 F. Because of its very high temperature properties, it is not recommended for temperatures below 2600 F.

If you have not taken advantage of the fast, low cost installation of castables for your high temperature requirements, we suggest you investigate B&W Kaocast and the new B&W Castable-3200. Your local B&W Refractories Engineer has all the facts.

A Mixed like structural concrete, B&W Refractory Castable-3200 can be poured, trowelled or gunned into place. • **B** High temperature laboratory furnace lined with B&W Refractory Castable-3200.

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick
B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics and Mortars
OTHER B&W PRODUCTS: Stationary & Marine Boilers and Component Equipment
Chemical Recovery Units • Seamless & Welded Tubes • Pulverizers • Fuel Burning Equipment
Pressure Vessels • Alloy Castings

BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST. NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

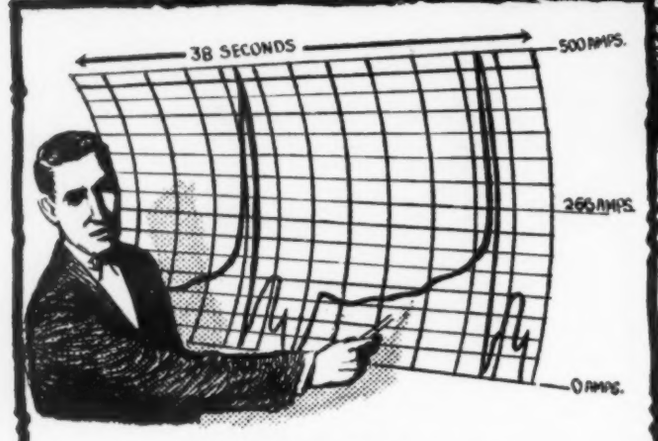
R-830

FACTS ABOUT Exide®

IRONCLAD® INDUSTRIAL TRUCK BATTERIES

NO MOVING JOB IMPOSSIBLE!

STEEP RAMPS, LONG HAULS, HEAVY LOADS... NO JOB IS IMPOSSIBLE WHEN ELECTRIC TRUCKS ARE POWERED WITH IRONCLADS. EXIDE MAKES BATTERIES WITH ADEQUATE CAPACITIES TO KEEP TRUCKS WORKING FULL-SHIFT...WITH NO LET-DOWN IN TRUCK POWER OR PERFORMANCE. USER COST RECORDS SHOW THAT EXIDE-IRONCLADS ARE YOUR BEST POWER BUY— AT ANY PRICE!



PORTRAIT OF AN EXIDE WORKING

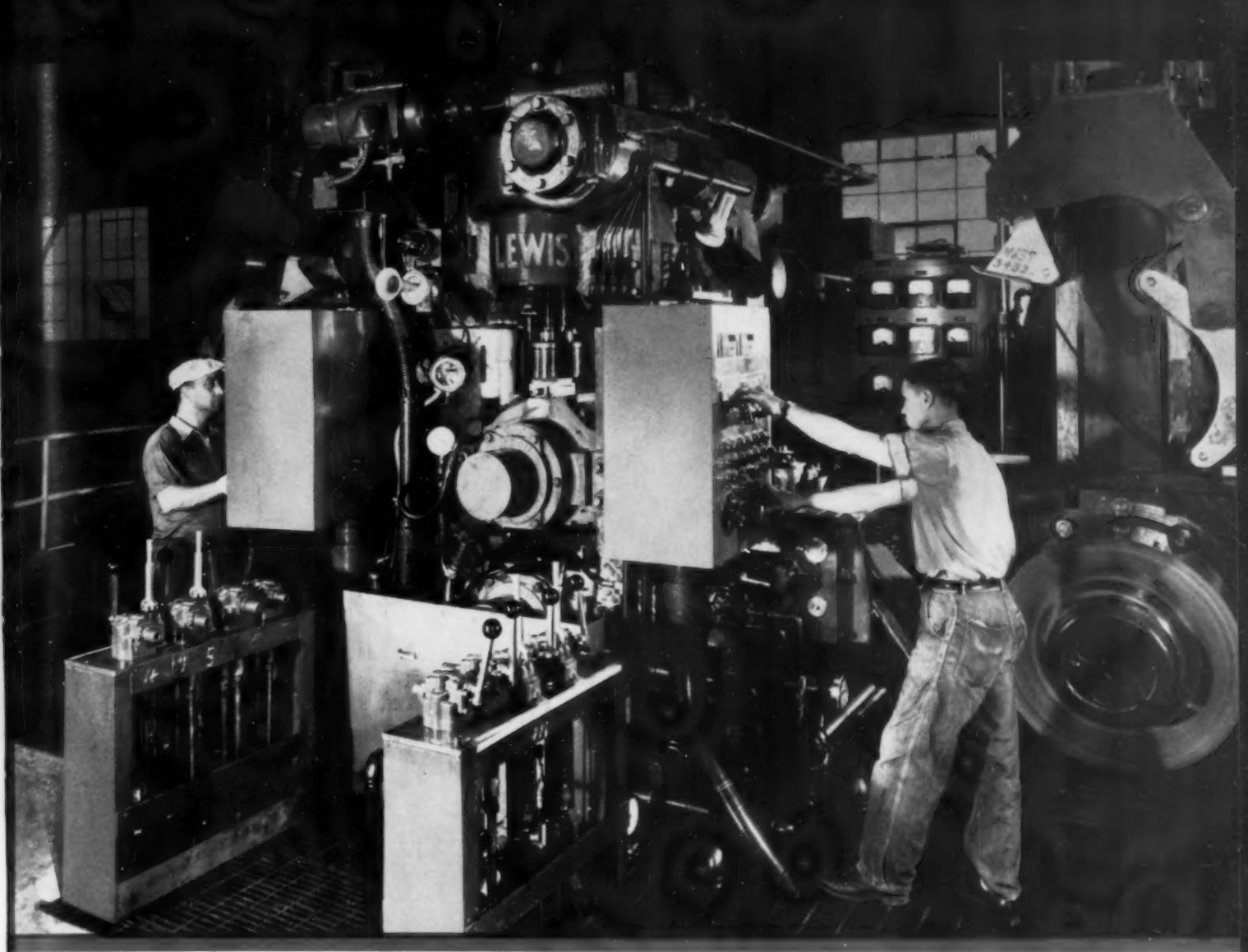
IN JUST TWO MOVES AND 38 SECONDS A FORK TRUCK MAY DRAW ENERGY FROM ITS BATTERY IN THIS PATTERN, IN RESPONSE TO 44 SEPARATE CONTROLLER OPERATIONS. IN AN 8-HOUR SHIFT, 3000 SUCH DEMANDS MAY BE MADE. EXIDE-IRONCLADS ASSURE RAPID, ACCURATE HANDLING OF MATERIAL... THEY RESPOND INSTANTLY TO THESE RAPIDLY RECURRING DEMANDS FOR HIGH POWER FOR SHORT DURATIONS.

TUBES OF POWER WORK FOR YOU INSIDE AN IRONCLAD

SLOTTED TUBES INSIDE AN IRONCLAD KEEP ACTIVE MATERIAL IN FIRM CONTACT WITH CONDUCTING GRIDS OF THE POSITIVE PLATE...THIS GRID PROTECTION LENGHTENS THE LIFE OF THE BATTERY. SLOTTED TUBES EXPOSE MORE ACTIVE MATERIAL TO THE ELECTROLYTE... FOR GREATER POWER. FINE TUBE SLOTS HOLD MATERIAL IN CONTACT WITH GRID LONGER...RESULT, THE IRONCLAD'S ABILITY TO DO YOUR MATERIALS MOVING JOB FOR A LONGER PERIOD OF TIME. THAT IS WHY EXIDE-IRONCLADS ARE YOUR BEST INDUSTRIAL TRUCK BATTERY BUY— AT ANY PRICE!

LET EXIDE HELP SOLVE YOUR INDUSTRIAL TRUCK BATTERY PROBLEMS. ❶ CALL AN EXIDE SALES ENGINEER FOR FULL DETAILS. ❷ WRITE FOR FORM 1982, A MANUAL ON INSTALLING AND MAINTAINING MOTIVE POWER BATTERIES.

Exide INDUSTRIAL DIVISION, The Electric Storage Battery Company, Philadelphia 2, Pa.



. . . new mill performs multiple operations on large variety of re-roll items

With this new Lewis Combination 2-high/4-high Reversing Mill you can economically handle a large variety of re-roll items in small tonnage quantity.

Designed and built by Lewis, the mill can cold reduce steel strip, skin pass, temper roll and gauge correct . . . either light or heavy gauge material . . . at speeds from 600 to 1800 fpm.

When operated as a 4-high mill, using 4½ and 16 x 20 rolls, it has driven back up rolls . . . each roll having its own individual motor without mechanical tie-in. When operated as a 2-high mill, using 21 x 18 rolls, the same motors and drive are used.

First of its kind ever built, this new Lewis Mill makes an ideal investment for any plant that requires a versatile mill to profitably handle a variety of re-roll products.

Whether you may need a mill of this type or some other kind, our experienced engineers and modern manufacturing facilities are always available to design and build sturdy mill equipment to meet your specific requirements.

LEWIS COMBINATION 2 HIGH 4 HIGH REVERSING MILL

BLAW-KNOX COMPANY • LEWIS MACHINERY DIVISION
PITTSBURGH 22, PENNSYLVANIA

BLAW-KNOX

LEWIS PRODUCTS: Two-High Mills • Three-High Mills • Four-High Mills • Strip Mills • Bar, Billet and Structural Mills • Plate Mills • Rod Mills • Coilers • Tables • Shears • Pinion Stands • Gear Drives • Roll Lathes

Blaw-Knox keeps crane cab temperatures down when furnace heat goes up

When the lid is off this 2400 F furnace for charging, its heat rises to surround the crane cab—making work practically impossible. To avoid the major work problem that such excessive heat creates for many foundries, the Rolls Division foundry of Blaw-Knox installed a Dravo Crane Cab Conditioner.

Like Blaw-Knox, foundry operators everywhere find that Dravo Conditioners are the answer to their overhead crane "hot spot" dust, dirt or fume problems. With Dravo Conditioners, cab temperatures are held at a 75-85 F maximum, while ambients may soar as high as 180 F. In addition to holding cab temperatures to a comfortable, efficient work level, Dravo Conditioners also remove dust, dirt and fumes from air entering the cab and provide year-round ventilation.

DRAVO
CORPORATION
PITTSBURGH, PENNA.
Sales Representatives In Principal Cities

No matter where they're put to work, Dravo Industrial Air Conditioners pay big dividends by providing effective protection from excessive heat, dust, dirt and fumes. We'd like to tell you more about how these efficient, rugged, easy-to-install units can help you. Why not mail the coupon now or phone the nearest Dravo sales office!

Dravo Corporation, Air Conditioning Department
Fifth and Liberty Avenues, Pittsburgh 22, Penna.

DRAVO

☐ Please send Bulletin 1301A "Crane Cab Conditioners."
☐ Please have a representative call at no obligation to me.

NAME _____

TITLE _____

COMPANY _____

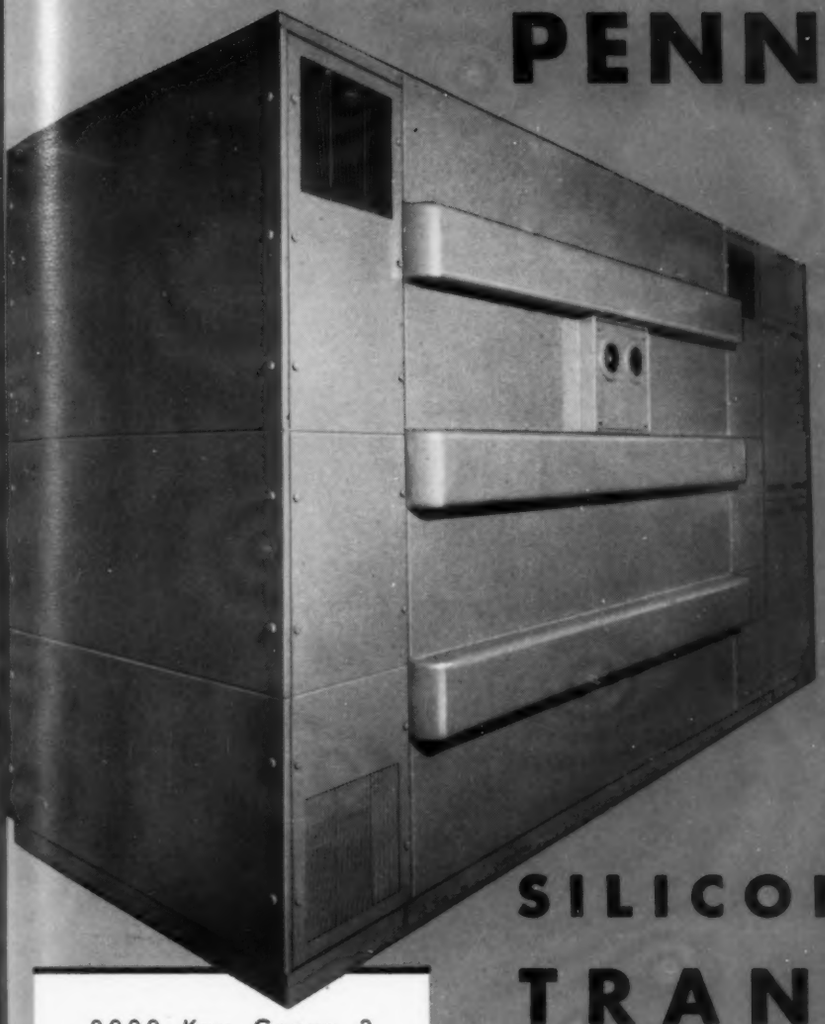
ADDRESS _____

CITY _____ ZONE ____ STATE _____

PENNSYLVANIA

suggests you consider

Fire and Explosion resistant



2000 Kva Group 3 Sealed-in Nitrogen Dry Type Transformer. H. V.—2400Δ volts. L. V.—480Δ volts. Three Phase. One of the largest Silicon-Insulated transformers ever built.

SILICONE-INSULATED TRANSFORMERS for Indoor Unit Substations

When planning an indoor unit substation, plan to install the safest substation transformer ever developed — a Pennsylvania Silicone-Insulated, sealed-in-nitrogen 150°C. Rise Dry Type Transformer.

Since oil-filled transformers constitute a fire risk, they cannot be used safely indoors unless expensive vaults and barriers are erected. And though askarel-filled transformers are installed indoors without vaults or fire barriers, they have been known to give off toxic HCl vapors under arcing. This constitutes a hazard to personnel. Therefore, Askarel transformers must be provided with gas absorbers or they must be vented to the outside air.

Pennsylvania Silicone-Insulated Transformers can be installed indoors "as is", without expensive vaults and other costly safety devices because inherently, they are the safest transformers ever developed. But safety is only one of their many advantages, for these "safest" dry type transformers also feature *smaller size, greater overload capacity, decreased cooling time, resistance to dirt and moisture, and minimum requirements for maintenance.*

If you want to know more about the Pennsylvania Silicone-Insulated Transformer — formerly called Class H — see your Pennsylvania representative or write to Pennsylvania Transformer Company, Box 330, Canonsburg, Pennsylvania.

PENNSYLVANIA TRANSFORMER COMPANY

A McGraw Electric Company Division • CANONSBURG • PENNSYLVANIA

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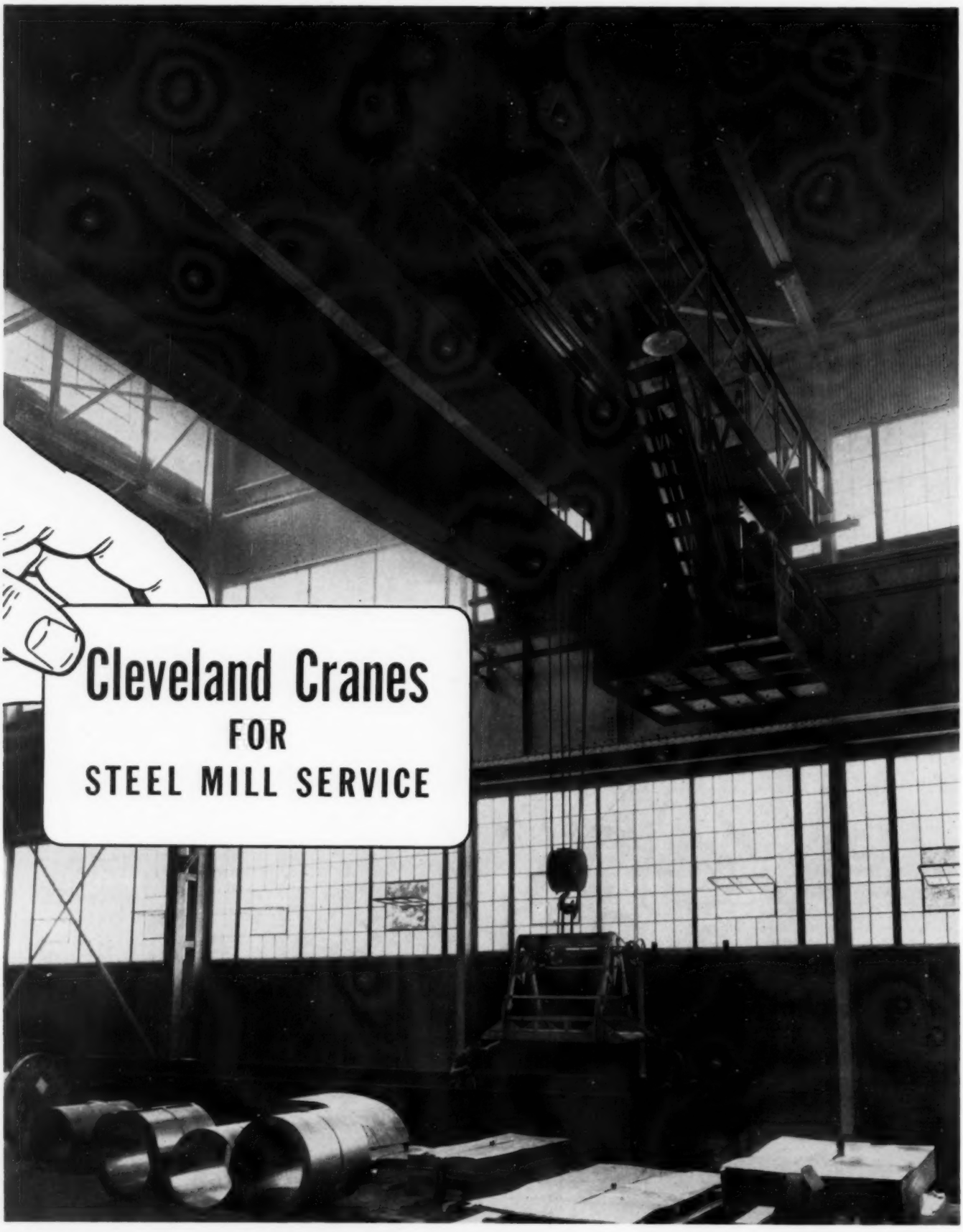

CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

ANOTHER fine western meeting last month at San Francisco indicates that this regional activity will be a regular annual event in the AISE program. Attendance was good, with 491 men registered (113 from east of the Mississippi River), and interest was high. A tip of our hats to the St. Francis Hotel, whose excellent cooperation and service helped to make the meeting so successful and pleasant. Some 40 wives managed to persuade their husbands to take them along. And California turned on a week of really beautiful weather — the kind the natives brag about.

▲

AS 1955 progresses, the outlook for business in general and steel in particular looks better. Steel profits for the first quarter are quite satisfactory. Fear of the third-quarter drop-off in steel production is lessening. At the moment, some classes of products — particularly plate and cold rolled sheet — are in heavy demand. Some gray marketing and conversion deals are appearing as production hangs close to record levels.

▲

SEVERAL steel producers are ready to install arc furnaces but are stymied because electric power to supply them is not available.

▲

LOTS of bosses have to be cranks because their employees aren't selfstarters.

▲

THE famous Soo Locks, connecting Lake Huron and Lake Superior, is celebrating its 100th anniversary soon. Since the Soo opened for business on June 18, 1855, more than 4,000,000,000 tons of raw materials, fuels, food stuffs and miscellaneous industrial products have moved through the locks. It is predicted that the next 25 or 30 years will see as much tonnage passing through the locks as in the first 100 years of their existence.

▲

WE'RE puzzled by an announcement that May 1-8 is National Can Opener Week. What does the modern hausfrau use the rest of the year?

▲

THE British steel industry is reported to be planning a four-year expansion program to cost $800,000,000. The plan involves an increase to 22,000,000 tons of ingot capacity, as well as continuous mills for sheet and tinplate.

▲

ACCORDING to the American Iron and Steel Institute, imports of iron ore in 1954 were the greatest in history, totaling 17,700,000 net tons. Venezuela led with 5,800,000 tons, followed by Canada with nearly 4,000,000 tons, Peru with 2,200,000 tons, Chile with 1,800,000 tons, Sweden with 1,700,000 tons and Liberia with 857,000 tons.

▲

A sage observer says some women work so hard to make good husbands that they never quite succeed in making good wives.

▲

A survey of its members made by the American Society of Mechanical Engineers shows some interesting results. Answers were returned by 56 per cent of the members. Of those answering, two-thirds said they did not wish they had spent more time on liberal arts subjects in their academic work; two-thirds spend one hour or less reading each issue of their monthly magazine; 70 per cent earn less than $10,000 per year; and 54 per cent have not attended section meetings. Of those answering, 38 per cent are registered or licensed professional engineers, half of which feel that this has not been of importance in their work.

▲

A personnel man, with tongue in cheek, says that industry wants its young engineers to have "a basic four-year engineering course, topped off by graduate work in a specific field, plus the physics or math of a doctorate, superimposed on a liberal arts background with a survey of economics added" — all of which explains the five to ten billion manhours per year which are now devoted to training in American industry.

▲

ACTUALLY, the five-day work week isn't so modern. Robinson Crusoe had all his work done by Friday.

▲

FIRE damaged or destroyed an estimated $870,984,000 worth of property in the United States in 1954.

▲

A new iron-base alloy containing 15-16 per cent aluminum and about 3 per cent molybdenum is said to have a very high stress-rupture life. It can be reduced into thin, flexible cold-rolled sheet, according to a research report of the Department of Commerce's Office of Technical Services.

▲

WE haven't heard much about production records recently, so a welcome bit of news is Inland Steel Co.'s announcement that its Indiana Harbor works, in March, shipped a record 348,877 tons of steel, while its 40 open hearth furnaces turned out 438,809 tons of ingots for another record. March production rounded out a record quarterly output of 1,241,804 tons of ingots.

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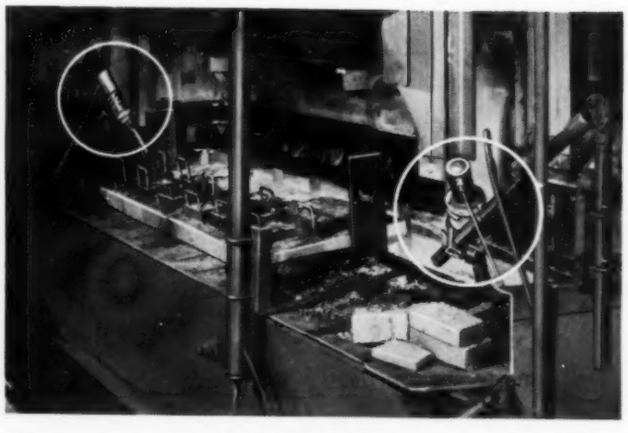
4. ***Estimate savings***—Next, he prepares a blanket annual order, grouping like items to get the biggest quantity discount. Savings may run as high as 50%.

5. ***Schedule deliveries***—Finally, he arranges a regular delivery schedule that assures that you will always have adequate supplies on hand. Give your Honeywell Supplies Man a call. He's at your local Honeywell office . . . as near as your phone.

New process for extruding steel gets high precision



Temperatures in the salt bath furnaces are detected by ***Radiamatic*** *radiation-type elements, which sight at the bath safe from fumes and high temperatures.*

Slot type furnace for preheating billets to be extruded is controlled by ***ElectroniK*** *instruments inside the control room at right.*

preheat with *ElectroniK** control

A REVOLUTIONARY IDEA in steel production . . . hot extrusion of tubes and complex shapes . . . has now become a manufacturing reality at United States Steel's National Tube Division in Gary, Indiana. Called the Ugine-Sejournet process, it consists of forcing preheated billets through a die, using molten glass as a die lubricant.

For the process to work satisfactorily, billet temperature has to be exactly right. If it's too hot, the billet seizes in the die. If it's too cold, the billet may crack the die or may not extrude.

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Instrumentation by Honeywell covers the full gamut of metal production processes . . . includes temperature, flow, fuel-air ratio and all other essential variables. For a discussion of your specific requirements, call your local Honeywell sales engineer . . . as near to you as your phone.

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● **REFERENCE DATA: Write for Catalog 1531, "*ElectroniK* Controllers," and Catalog 9301, "*Radiamatic* Pyrometers."**

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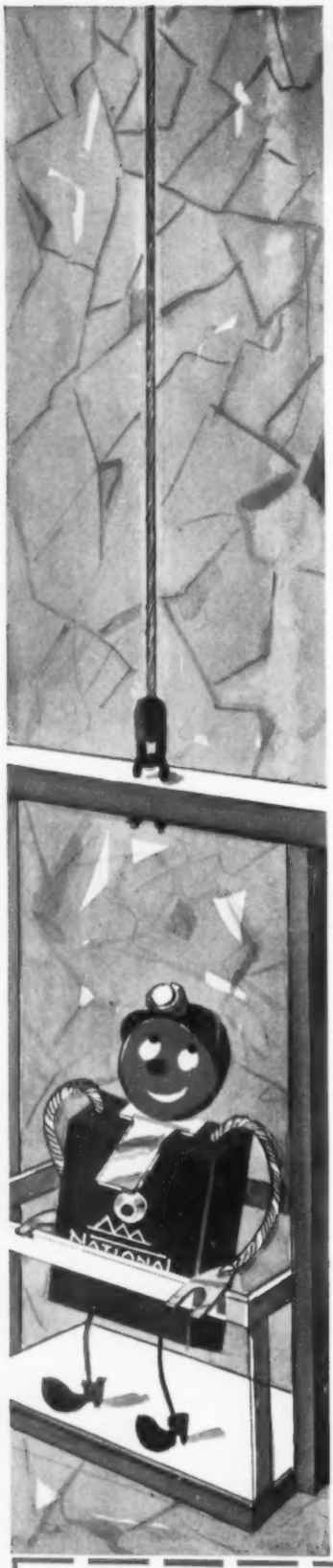

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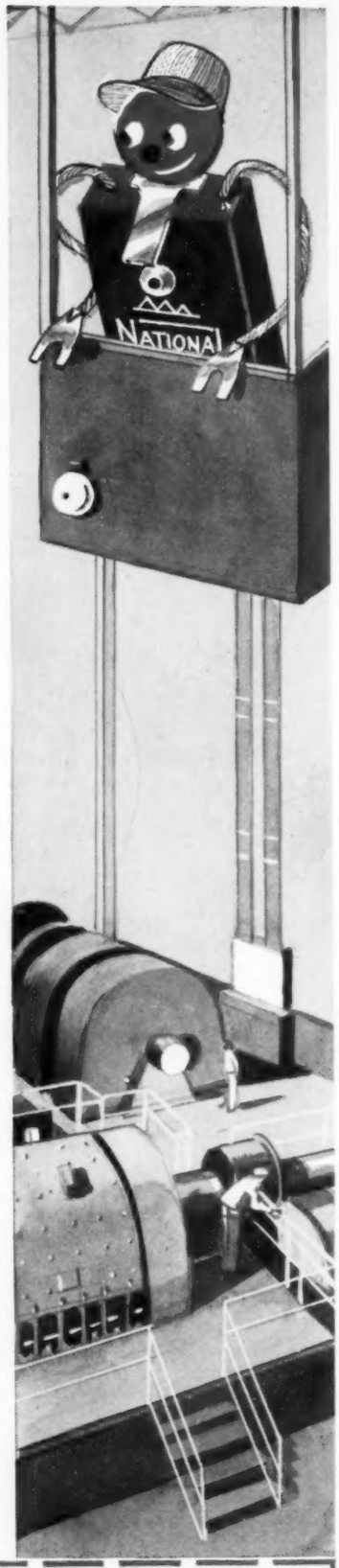

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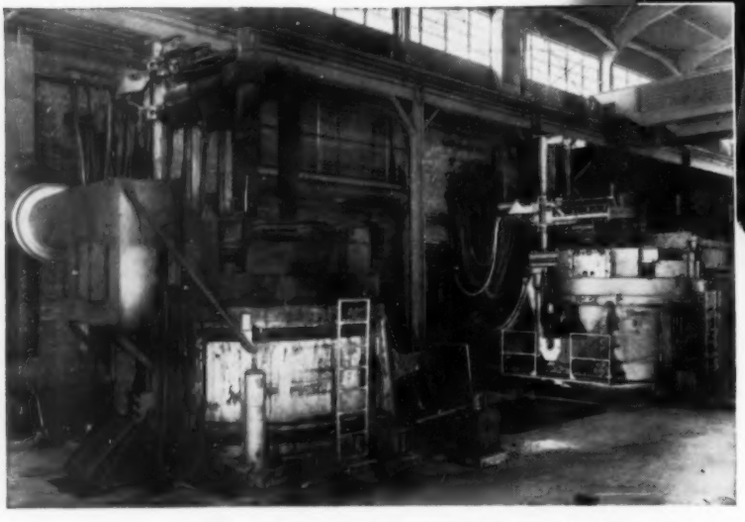

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MOORE RAPID

WHEN YOU MELT... *Lectromelt*

By E. M. BENEDICT, Superintendent, Roll Shop, South Works, United States Steel Corp., Chicago, Ill.

ROLL KNURLING at South Works of U. S. Steel

. . . . the use of knurled rolls on a slabbing mill has increased mill tonnage and reduced the number of broken rolls . . . . experience at other mills does not necessarily give same results . . . . many local operating conditions have an important effect on results with knurling practice, as does the type of knurling pattern which is employed . . . .

▲ THE demand for improved quality in steel products and the necessity of low operating costs have required mill management to employ all means available to them to improve quality and increase operating efficiencies.

Early in 1949 the management of the South Works 44-in. slab mill, the largest producing unit in the rolling division, was confronted by such a problem. Inspection of slabs at the billet dock indicated a marked increase in the number and extent of surface tears. Some change either in steelmaking or heating and rolling practices appeared to be responsible, and it was apparent that corrective measures would be necessary at once to eliminate this cause of high costs.

The solution of this problem was not a simple one and required extensive study and experimentation to solve. Operating practices were reviewed and closely supervised to insure that all known techniques were employed to produce the best quality possible. The correction of deviations in practices and the employment of all technical tools in the making and heating of steel did not produce the desired results, and attention was then directed to the rolling practice.

The effects of various drafting practices upon the surface quality of the steel being rolled resulted in the development of a method to minimize this defect. The idea involved was to alter the surface of the roll in a manner which would allow localized interrupted working of the slab surface and shorten or stop the tearing action. The development of this idea recalled past experiences and also the present use of roll surfaces altered by the application of various types of ragging, which were usually employed to facilitate entry of the steel into the rolls and to prevent slippage during rolling.

Figure 1 — This type of ragging, often used in structural rolls, had little effect on the surface condition of the steel.

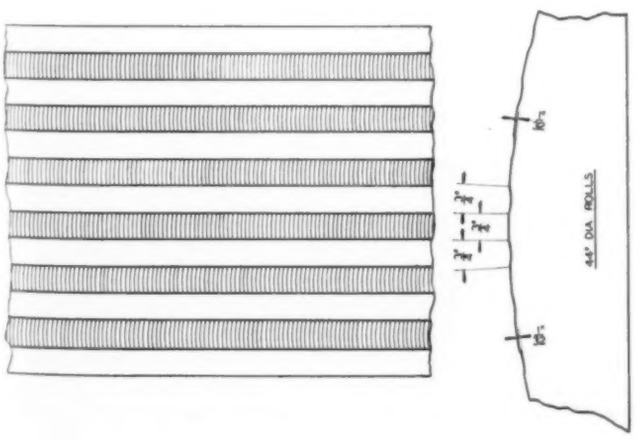
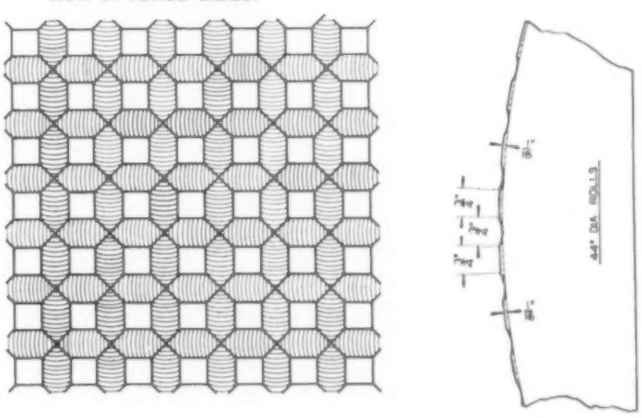


Figure 2 — This type of ragging improved surface condition of rolled slabs.



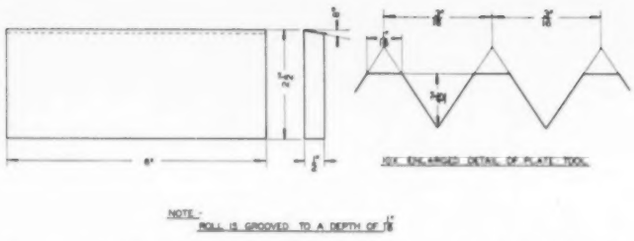


Figure 3 — Roll grooving tool shown was developed by the Tennessee Coal, Iron and Railroad Div. of U. S. Steel.

Past experiences with ragging in use and with the types tried and discarded had furnished knowledge as to what could be safely used. Too severe ragging caused unwanted surface defects, and additions of alloys to the steel being rolled appeared to make it more sensitive to this treatment. The production of all of the plain carbon and alloy open hearth grades of steel as well as electric furnace steels on this unit complicated this problem, and dictated that caution should be exercised in the initial approach.

The first method of altering the roll surface was to employ a type of ragging used on structural rolls, which did not have any harmful effects upon the surface of the steel. The ragging was done by using an air hammer and chisel, grooves being made longitudinally on the roll body 1/32 in. deep, 3/4 in. wide and with a 1 1/2 in. pitch, as shown in Figure 1. When this roll was used, it had little or no effect upon the surface condition of the steel and was not further used.

The next step was to have the machine shop machine grooves lengthwise of the roll 1/16 in. deep, 3/4 in. wide and with 1 1/2 in. pitch. The roll was then put into a roll lathe and the same grooving turned around the roll, giving a pattern shown in Figure 2. This pattern when used in rolling greatly improved the surface conditions of the rolled slabs and minimized the surface tears.

This pattern was discontinued however as several undesirable features overcame the advantages gained by its use. The portions of the slab surface not showing visible defects were believed to contain defects covered by primary and secondary scale in the pockets formed on the slab by the protrusions on the roll body. Another problem was caused by the flaring and gouging action of the scarfing torch when used to remove defects, and when slabs were conditioned by swing frame grinding, the bumping of the wheel over the uneven surface caused considerable complaints from the operators.

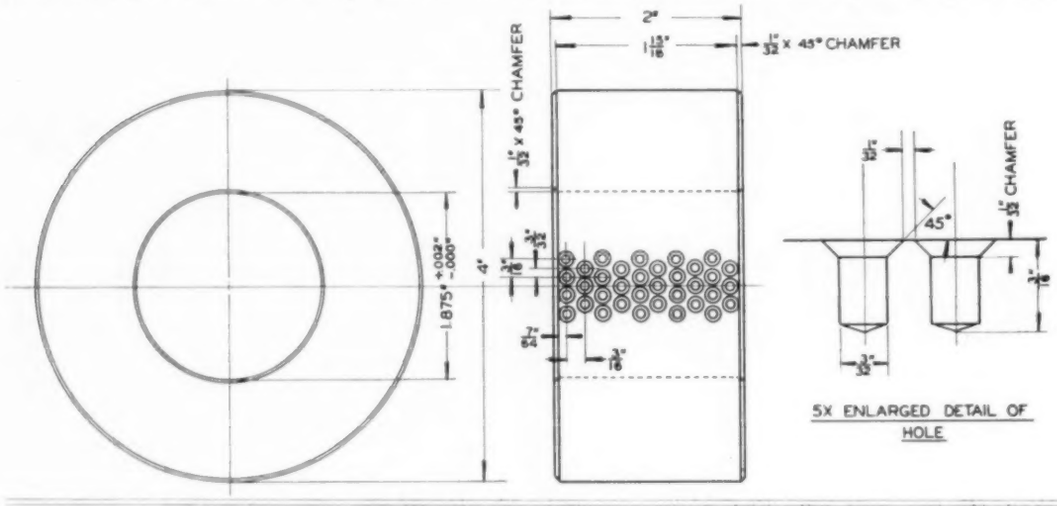


Figure 4 — This knurling wheel is used along with the grooving tool shown in Figure 3.

About this time (1950) a pattern of roll knurling developed by the Tennessee Coal, Iron and Railroad Co. received considerable publicity and appeared to be the answer to the 44-in. slab mill rolling problem. This pattern was applied to the slab rolls by cutting grooves around the roll with a flat form tool shown in Figure 3, and a knurling wheel, Figure 4, was forced into the roll to displace part of the metal and form a

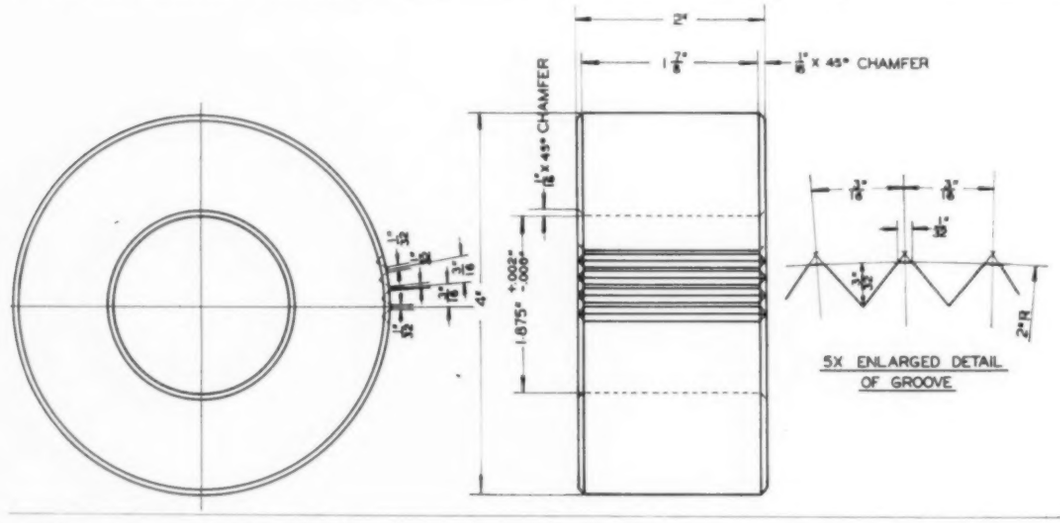


Figure 5 — This knurling wheel is used for the final pattern developed at the South Works.

series of protrudences similar to the holes in the knurling wheel. The actual displacement of the metal to fill the holes was so great that the equipment would not stand the pressures involved, so further work was done and the pattern now used was developed.

The forming of this pattern is done by using the flat tool shown in Figure 3 to turn the grooves, and the roll is grooved to a depth of $\frac{1}{16}$ in. The knurling wheel shown in Figure 5 is then pressed into the roll to the bottom of the turned groove forming a pyramid approximately $\frac{1}{8}$ in. square at the base, $\frac{1}{16}$ in. square at the top and $\frac{1}{16}$ in. high and is produced with a $\frac{3}{16}$ in. pitch. The surface of the knurled roll is shown in Figure 6. This shape was developed as it was thought that the tapered sides would make a depression in the slab which would roll out on each successive pass easier than a straight sided knurl, and also because it was much easier to form on the roll surface. This knurling did produce the desired improvement in surface quality that was sought.

Two things were immediately apparent to the mill roller when the rolls were put into use. The first one was that the slip and grab action between the rolls and steel, with the attendant shock between spindles, motors and rolls was reduced. The next observation was that light scabs were lifted from the slab surfaces.

Inspection of the slabs in the slab yard, Figure 7, showed that the tears we were originally concerned with were greatly reduced, and also the light seams, scabs, arrowheads, rolled in scale and other defects encountered in slab products were also reduced or eliminated.

A large portion of the product produced on this unit is further processed into sheets and tin plate at our Gary Works. The reaction of the personnel at these units when they were consulted concerning this change at first was one of skepticism as they thought the knurled pattern would smear over defects and make inspection difficult. Their acceptance of this product can best be shown by the fact that when slabs produced on worn rolls are received, they complain immediately as their conditioning costs go up. Surface removal of this product during conditioning was reduced about one third when rolled on knurled rolls.

A condition exists in the use of these rolls which has led to a change in operating procedure, as the top roll wears smooth in about one-half the time required to wear out the bottom roll. Roll changing previously was done on a periodic basis on a non-operating turn with both the top and bottom rolls changed at the same time. The present practice makes it necessary to change rolls as soon as product surface conditions require, because when one roll wears smooth, a slipping and grabbing action occurs which causes a slab defect as shown in Figure 8.

While not initially expected, the use of knurling increased roll life substantially. A comparison was made by the roll shop between the roll life of plain and knurled rolls after six months use, but the results were so much greater than expected that a longer comparative period was desired before a report was made. At the end of one year, the tons of product per inch of roll used was calculated and the savings in roll cost were estimated to be significant.

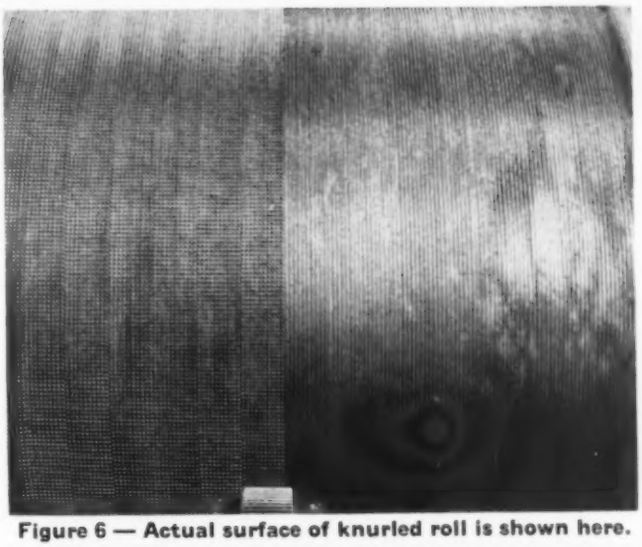


Figure 6 — Actual surface of knurled roll is shown here.

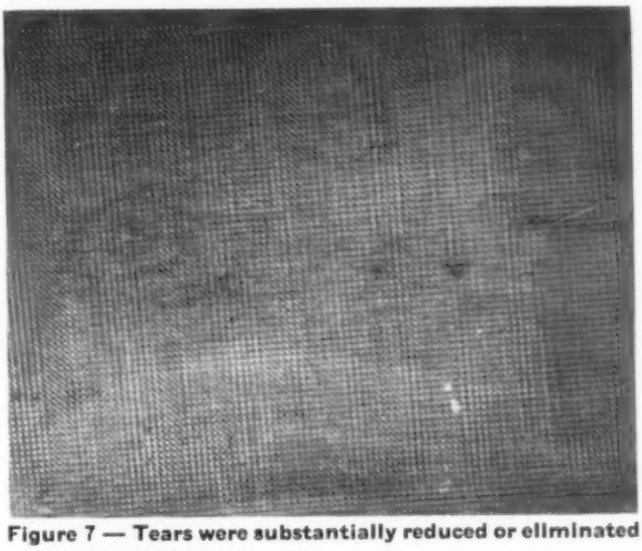


Figure 7 — Tears were substantially reduced or eliminated with knurling.

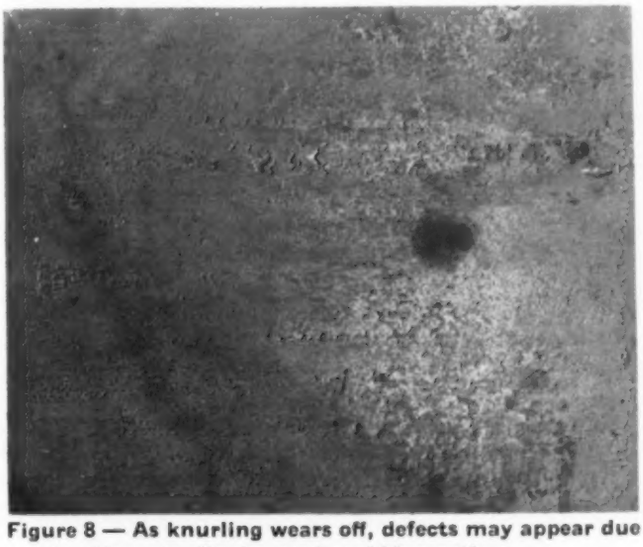


Figure 8 — As knurling wears off, defects may appear due to alternate slipping and grabbing action.

Another feature of this type of knurling is the effect of fire-cracking of the roll surface. A smooth roll body fire-cracked in a small pattern with continuous cracks running around the roll which gradually deepened and caused roll breakage. The knurled surface, when any fire-cracking is present, has a large pattern without

continuous lines, and has reduced the number of rolls broken due to this cause as shown in Table I. The broken rolls for the last three years started out as plain rolls and were not knurled until one-third to one-half of their life was used, and were firecracked deeply during this time. None of the rolls used which have been knurled throughout their life have broken.

The use of this type of knurling has been extended to several other rolling operations and the results have varied.

TABLE I

44-In. Slab Mill Rolls

No. of rolls	Tons rolled	In. of roll used	Tons per in.
9	3,504,100	36½	96,200

Knurled Rolls

No. of rolls	Tons rolled	In. of roll used	Tons per in.
4	2,553,400	10½	243,000

Broken Rolls (All Causes)

1947	1948	1949	1950	1951	1952	1953
5	4	6	4	1	1	2

One of the blooming mills produces slabs processed into flat forgings, and the secondary scale trapped in the knurled pockets had no chance to be removed from the surface of the steel as it would during a rolling operation, and the knurled pattern appeared on the finished product. For this type of product the roll surface is altered by using the knurling wheel in Figure 5 to produce a straight line knurl $\frac{1}{64}$ to $\frac{1}{32}$ in. deep across the roll.

A trial was made on the first two stands of the 12 to 16 in. alloy bar mill, but the pattern showed up on parts of the finished bar as a series of short seams and the straight line knurling was again used.

A large tonnage of bessemer steel billets are produced on a 22 in. cross country type structural mill. To facilitate entry of the bar into roll passes and to prevent slippage it is necessary to reduce roll drafts. The flat and edge passes in the first and second stands and the diamond and square passes in the third and fourth stands were grooved and knurled. All slippage was eliminated and entry trouble disappeared with the result that production was increased over 5 per cent.

The grooved and knurled pattern is also used on flat rolls when breaking down blooms for standard structural shapes and this practice aids in breaking up furnace scale and reduces slippage.

The first step in the operation of knurling a roll is to turn off the worn out knurling. The plain roll used before knurling was developed required from $\frac{5}{8}$ to 1 in. reduction and took a roll turner about seven to eight hours to perform this work. The present use of knurling requires only $\frac{1}{4}$ in. of dressing and with the grooving and knurling, a total of about 12 hours are required to complete the operation.

Until the first of this year knurling was done by forcing the wheel into the roll using the conventional roll turning equipment, but this was hard physically upon the operator. Tightening up the tool with a six-ft wrench, and when the knurling was completed removing the pressure, required considerable effort, and there were indications that eventually injuries might result from this operation.

The present equipment used is an air-hydraulic arrangement shown in Figure 9. A 150 to 1 air multiplier is used to apply 7000 pounds pressure to a hydraulic ram which in turn exerts about 20 tons pressure on the tool. The knurling is completed in two revolutions of the roll. Only a simple manipulation of a valve is necessary to apply or release the required pressure.

The types of grooving and knurling that have been developed so far are not the answer to all our rolling problems. The work completed has indicated that further experimentation will result in increased benefits, and an active program is being followed to add to our knowledge and use of this tool in the rolling of steel.

DISCUSSION

PRESENTED BY

MARTIN L. WEIKERT, Superintendent, Rail Mill and Roll Dept., Bethlehem Steel Co., Sparrows Point, Md.

LOUIS MOSES, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

T. D. CLIFFORD, Superintendent, 80-in. Hot Strip and 45-in. Slab Mills, United States Steel Corp., Fairless Hills, Pa.

A. M. CAMERON, Superintendent, Rolling Mill, Atlas Steels, Ltd., Welland, Ontario, Canada.

J. W. LUOMA, Roll Metallurgist, Continental Foundry and Machine Co., East Chicago, Ind.

W. T. MILLER, 620 First Avenue, Bethlehem, Pa.

WADE F. HOFFMAN, Superintendent, Roll Dept., Jones and Laughlin Steel Corp., Aliquippa, Pa.

E. M. BENEDICT, Superintendent, Roll Shop, South Works, United States Steel Corp., Chicago, Ill.

Martin Weikert: We have, at Sparrows Point, a 40-in. blooming mill, a 54-in. blooming mill and a 40-in. slabbing mill which roll slabs for a 56 and a 68-in. hot strip mill.

This pattern of ragging was applied on both blooming mills, the slab mill and the first stand of both strip mills. After nine weeks of usage it was found that the pattern showed on the surface of the hot rolled strip. Its use was stopped immediately and it has not been used since.

Louis Moses: We must all thank Mr. Benedict for his generous and able reporting of the outstanding accomplishment attained with his ragging practice. It would be a tremendous task to even attempt to assemble all the many known successful types of ragging used by the industry's bloomers and evaluate them on a score board. What discounting is necessary because of the respective mill conditions severally encountered?

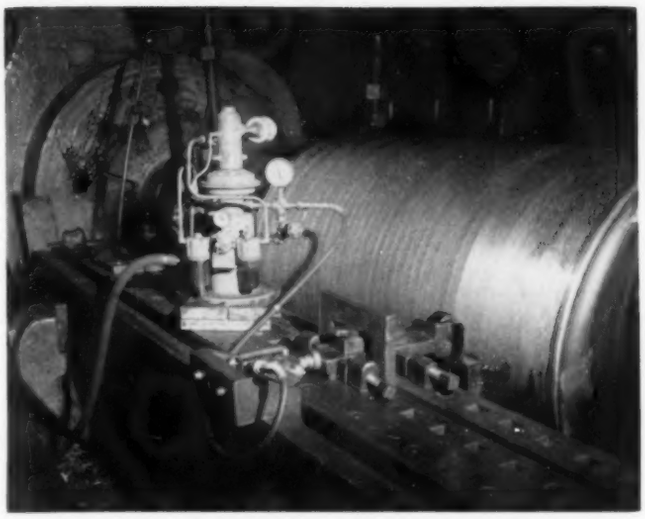


Figure 9 — An air hydraulic arrangement is used to apply the pressure to the knurling tool.

Indeed we can ask what are the influences accompanying each condition if it was observed as a variable? Is the ingot scale at one plant more abrasive or tenacious than at others? It would be impossible to have identical cooling water applications as a control so that this important factor, a subject in itself, would be eliminated when evaluating or comparing ragging or knurling types. What effects are present or peculiar to the drive, speed of reversal, etc.? What constitutes the very best roll-material? It may not be news to some but up to a very few years ago a well known blooming mill used plain carbon rolls, claiming superior results over the alloys used on most mills. What drafting practices are harmful and what would be the most beneficial from the standpoint of roll resistance to wear? It would be a thankless task when we consider that every one of the existing ragging types has its stalwart and enthusiastic adherent and mighty few apologists. Certainly these clever operators do not close their minds when they learn about another fellow's success with something different. Each one visualizes what a change will mean and weighs it in the light of either necessity or possible improvement to his operations or costs. It will be found that they have good and sufficient reasons for their individual choices as based upon experience as well as need. These types of ragging range from the simplest chipped-in ragging as cut straight across the bull-head (or groove), extend to those chipped-in diamond patterns arranged diagonally, raised Canadian ragging, sundry combinations of chipping and raised bosses, or raised ragging and knurling, some of the latter resembling Mr. Benedict's kind. There are as many types as there are mills and some mills have operated with none at all.

How would one go about comparing varying intensities of fire-cracking? If there is any one merit to Mr. Benedict's type of ragging which is appealing and highly important it is the virtual absence of fire-cracking which I have witnessed first hand. Our roll-makers would like to know the cause of fire-cracking. The question will be raised elsewhere in this meeting's program on whether or not the boundaries between the probable dendritic surface metal structure are the cause. One thing appears to be quite certain, the surface pattern of Mr. Benedict's ragging presents a flexible accordion effect permitting ranges of expansion and contraction of the particles on the roll surface without creating stresses between them which could and doubtless do start detail fracturing, otherwise growing into the familiar fire-cracking. A fire-crack, once started, cumulatively grows wider and deeper, if only because of the entrapped water between the walls becoming steam at tremendous pressures corresponding to 2,000 to 2,200 F temperature.

Discouraging results accompanied a trial of Mr. Benedict's ragging on a 40 x 82-in. slabbing mill. The primary objective of any ragging consists of conditioning the roll surface for maximum tonnage rates, no slippage at any time, a maximum roll life through small reductions at each dressing. It goes without saying that this must be accomplished with no damage to the surface in its later processing into flat, or other, rolled products. With these fully and confidently expected, an added incentive of the trial was to remove any and all adhering scale which occasionally occurs in patches serving to conceal from the scarfers what could be defects lying beneath. Another member of my company can better report the results of this thorough trial in detail.

This by no manner of means discounts in the slightest degree the benefits which Mr. Benedict derives at South Chicago with his many kinds of steel and particularly with the slabs for a customer's strip mill. Perhaps some one else will try it and find advantages every bit equal to Mr. Benedict's and completely opposite to the results of our trial. Until the principles governing the use of blooming and slabbing mill rolling are better known the job of suitably applying respective ragging types must necessarily depend upon trial and error with local conditions becoming the criterion for adoption.

T. D. Clifford: Knurled rolls were used at the start of Fairless Works 45-in. slabbing mill. Our experience with knurled rolls was not as satisfactory as it is at South Works due to fairly large pieces falling out of the roll. The result is that smooth rolls are now being used. Trouble with the knurled surface was also experienced on the 80-in. hot strip mill slab depiler which helped to influence the installation of smooth rolls. Discussions with Mr. E. Benedict in the past two weeks have caused the reinstallation of knurled rolls to be reconsidered at Fairless Works.

Al Cameron: I would like to ask if knurled rolls have been used in rolling stainless slabs?

J. W. Luoma: With respect to the author's statement about the elimination, or the reduction of fire-cracking due to knurling, I am wondering whether the 20 tons pressure that he used might not have some effect.

By working the roll surface under this pressure, he may be building a residual compression in the outer layers. Consequently, when the cooling water strikes the hot outside surface, this residual compression must be overcome before the surface can go into tension to produce fire-cracking.

W. T. Miller: Mr. Moses spoke of running dry on rolls —this we do on sensitive tool steels. Running dry appears to have a considerable bite and grip on the steel.

My actual experience with ragging is limited since

we roll alloy steel exclusively at our plant. Ragging that is too deep, particularly where heavy reductions are taken, can be injurious to the steel being rolled. On heavy reductions, the steel enters the rolls considerably slower and delivers slightly faster than the roll surface speed and has a tendency to strip back the ragging imprints. This is analogous to drawing a bar through a deeply ragged die and stripping portions of the bar surface.

Years ago, just before we entered the alloy game exclusively, and were still rolling carbon steel, we had a knurling tool or knurling buggy, as we called it, to knurl our blooming mill rolls right at the mill. This

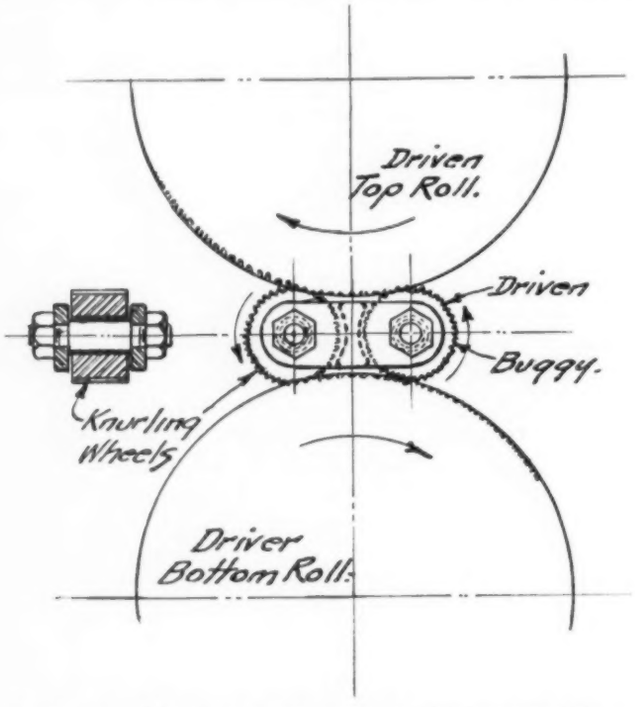


Figure 10 — With this arrangement, it was possible to apply the knurled surface to the roll while in the mill.

knurling buggy consisted of two knurling wheels approximately 6 in. diameter x 4 in. width. See Figure 10. The two wheels were held in position by a forged steel "H" type frame. To knurl a set of rolls we would place the knurling buggy between the top and bottom rolls and throw off the top driving box. This would reverse the rotation of the top roll, which was now driven by the knurling wheels which in turn were driven by the bottom roll. The top roll was screwed down onto the buggy wheels that were between the rolls, causing the pressure necessary to knurl the rolls. With this procedure the rolls could be re-knurled right at the mill without roll change or roll shop assistance. This buggy came to an unhappy end. When one of the rollers not too familiar with the procedure forgot to throw off the top driving box, the buggy rolled through the rolls and broke. The buggy was never replaced as we soon discontinued the rolling of carbon steel. Contrary to the usual metallurgist's opinion, I feel there are times when the proper type of ragging would help the mill operation rather than hinder it.

Wade F. Hoffman: It is our opinion that nearly every mill has different problems resulting from different type steels, roll diameters, power available, speeds and production requirements, thus the best solution for one may not be the answer for another.

We are using a fluted ragging and so called "pebbling." The fluted ragging is machined on the roll in a roll lathe, by means of a tool, which is actuated by a cam, causing intermittent cuts on the roll. This practice is quite common in the industry. The whole surface is then peened, using an air hammer with a four pointed chisel. This peening results in a rough pebbled appearance. These numerous small depressions apparently do not permit any concentrations of heat, or any quantity of trapped water or steam, thus minimizing fire-cracking and steam cutting, probably in much the same manner as described by Mr. Benedict. Rolls may be repebbled in the mill if necessary.

We do not roll high alloy steels, and the mill is rather fast, at times rolling over 70 ingots per hour. We have recently tried a set of rolls with a circumferential open V grooves ½ in. centers and $\frac{3}{64}$ in. deep, and the top of the projections are knurled. This design, which has proven popular in some plants, cut production to under 50 ingots per hour, so it was discontinued.

I have a question to ask Mr. Benedict: How many tons are rolled, or days operation between roll changes?

E. M. Benedict: The general comments concerning the specific use of knurling can be answered as follows: The first consideration is to use care in the application of knurled rolls. We have found that our pattern cannot be used indiscriminately. When used in the roughing stands of a structural mill the pattern carried through on the finished section when the steel contained 0.50 per cent carbon or more.

Mr. Cameron's question can be answered by stating that all grades of open hearth alloys and electric furnace steels, with the exception of tool steels are rolled on our 44-in. slab mill. Specifically all stainless grades, Hadfield manganese, silicon grades, high carbon grades and vitreous enamel base grades.

Mr. Luoma's thought that the compression of the roll surface may reduce fire-cracking may be correct, but I do not believe that the bottom of the grooves running around the roll, where logically fire-cracking should begin, receives any compression due to the knurling action. The ridges running around the roll are compressed, by the knurling wheel, but we are unable to move enough metal to allow the wheel to go to the bottom of the groove.

At one time we tried knurling a roll with a pattern which had the same effect as pebbling the surface, by using a wheel with small pyramids on the surface, and these were pressed into the roll surface. This might accomplish the same purpose as far as fire-cracking of the roll is concerned, but at the time this was tried, the aim was not to improve roll usage but to reduce tears and improve slab surface. The present results obtained in regard to roll usage are a by product of the original desire to improve surface quality.

The tons per roll dressing have varied from 29,000 tons to 139,000 tons with the smaller tonnage amounts rolled on the top roll. Normally two top rolls are worn out before the bottom roll requires dressing. Several theories have been advanced as the reason for this condition, one of which is that the scale remaining or the top surface causes the excess wear.

The Fairless Soaking Pits

By CHARLES R. WILT, JR., Combustion Engineer, Loftus Engineering Corp., Pittsburgh, Pa.

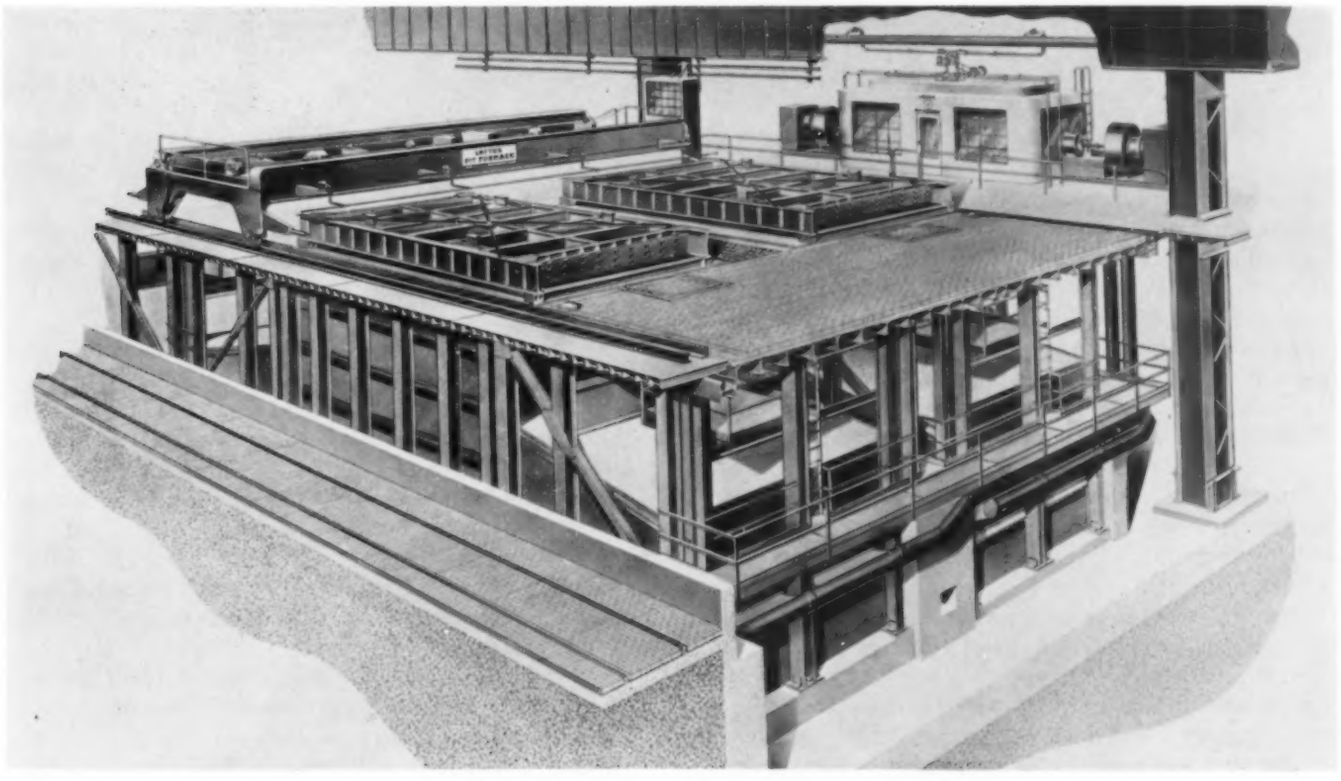
. . . . among the developments which have converted soaking pits into ingot heating furnaces are features of automatic control, flexibility in operation, low maintenance, quality of heating and economy of operations . . . .

▲ THE 45-in. mill soaking pits at Fairless Works of United States Steel Corp. are two-way, top fired recuperative furnaces. The furnaces are arranged in ten batteries of two furnaces each, the batteries running north to south in line with the 45-in mill. The 140-ton ingot capacity of each pit furnace gives each two-pit battery capacity for a 280-ton open hearth heat. The general arrangement of the pits is shown on Figures 1 and 2. The furnaces are rectangular in plan, and on centerlines are 14 ft-6 in. wide, 20 ft long and 15 ft deep to the solid hearth. With a 12-in. coke breeze bottom and a maximum ingot height of 90 in., the 15 ft depth gives ample combustion space above the ingots.

The two burners are located on the centerlines of the end walls and fire diagonally across the furnace in the space between the ingots and the pit cover. The burner gas tube is approximately 5 ft-10 in. long. The inner 4-ft section, subject to furnace heat, is of centrifugally cast alloy (21 per cent chrome, 9 per cent nickel), while the portion extending through and outside the end walls is standard weight steel pipe.

The furnace walls are veneered with 9 in. of quarried silica stone. The stone is backed up with 9 in. of first quality firebrick and 4½ in. of block insulation laid against a ¼- in. steel plate. The silica begins 21 in. above the hearth and is carried on seven courses of burned chrome magnesite, which are corbelled in 4 in. toward the center of the furnace. The center and side jambs of the waste gas ports, which carry a two-piece silica stone lintel, are also burned chrome magnesite.

Figure 1 — Soaking pits at the Fairless Works consist of ten top-fired recuperative 2-pit batteries.



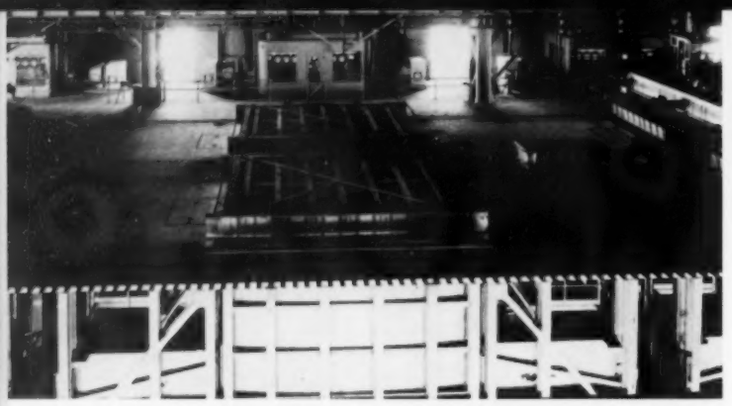


Figure 2 — View of soaking pits from pot car side shows pits, covers and control houses.

Figure 3 — A slight positive pressure keeps the control houses dust-free.

Special shapes, such as the curb tile and the furnace pressure and thermocouple blocks are first quality fireclay. The burner ports were poured in position of a high temperature castable refractory. The hearth is carried on 18-in. wide flange beams, spaced on 1 ft-0¾ in. centers. Four-in. channels are laid across the beams, flange to flange, web up. The 21½ in. bottom is laid directly upon the channels and is composed of 5 in. of high temperature insulating brick and 16½ in. of first quality firebrick.

bustion air and waste gases, thereby holding air leakage to a low value.

The waste gases leave the furnace at the hearth line through two waste gas ports in either end wall and enter a distribution chamber on top of the recuperators. Passing downward through the tubes and between the rider walls, the gases then enter the waste gas ducts. The two ducts, one from either end of the furnace, have an inside diameter of 2 ft-8 in. and are lined with 2½ in. of second quality firebrick backed

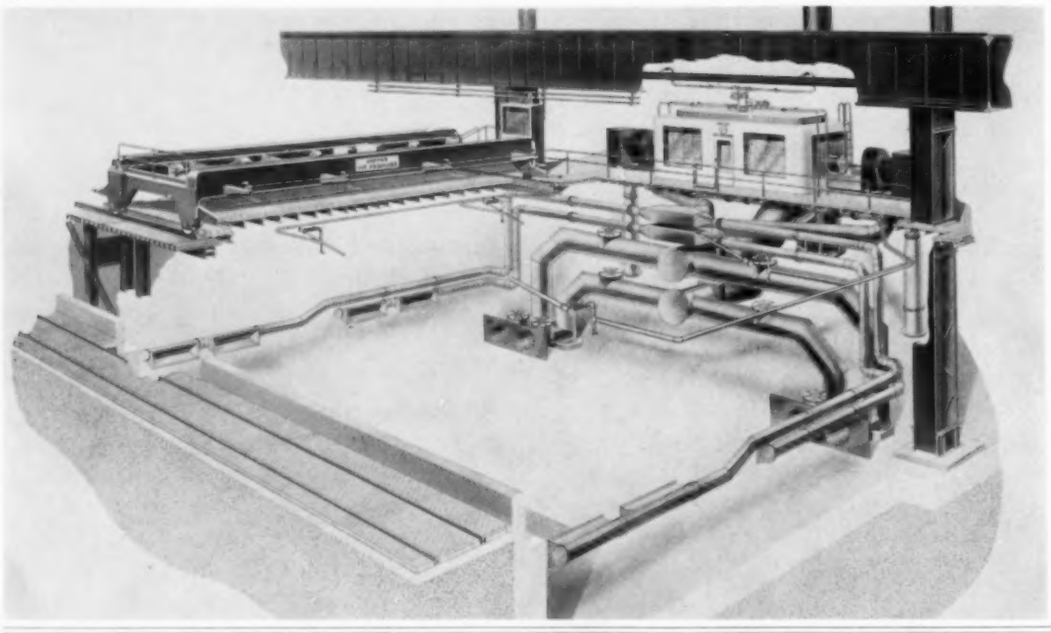


Figure 4—General arrangement of combustion system of soaking pits at the Fairless works.

Each furnace has two recuperators located below and adjacent to the end wall waste gas ports. In plan, the recuperator chamber is 14 ft-9 in. by 6 ft-9 in., with a tube depth of 7 ft-9 in. In each recuperator, there are 189 vertical tubular passages, 4½ in. in diameter, which present an area of 20.8 sq ft for waste gas flow. The combustion air enters the bottom of the recuperator and makes three horizontal passes around the tubes as it rises to the burner port. The tubes are of sagger clay with the exception of those at the combustion air entry, which are silicon carbide.

The recuperator, due to simplicity of design and construction, is self-sealing by virtue of its own weight. A special flexible ceramic gutter seals the top of the recuperator to the side walls of the chamber to allow for expansion and contraction caused by variation in operating temperature. The recuperators are designed to operate at low velocities and pressures, reducing to a minimum the pressure differential between the com-

with 1½ in. of block insulation. The ducts then make a horizontal run toward the center of the furnace where they combine into a single header leading to the base of the stack.

It must be remembered that the arrangement just discussed applies to only one furnace of the battery. The waste gases from the furnace on the stack side of the battery pass directly into the waste gas system; however, those from the outside furnace must pass beneath the recuperator of the near furnace. The waste gas systems from both furnaces are then combined before they enter the stack, making it possible for one stack to serve two furnaces. The stacks are 115 ft high, are lined with second quality firebrick and have an inside diameter of 5 ft-0 in.

To determine which would give the best service, three different types of refractories have been used in the pit covers. Four covers are of a rammed plastic green clay, four are of the same castable that was used

in the burner ports and twelve are of suspended burned refractory shapes. Since no structural changes were required in the covers to accommodate the different refractories, the same edging tile and sand seal castings were used on all twenty covers.

Furnace controls—The three cover carriages span the batteries and the hoist controls of each are interlocked, through two control rails, to the fuel shut-off controls of each furnace located on top of control house (Figure 3). The cover carriages have two hoists, one for each furnace of the battery. Fuel shut-off and cover lift are controlled through a specially designed, manually actuated, cover hoist control incorporating provision for manual fuel shut-off before the cover can be raised. The safety shut-off valve, which can be operated from either the crane or the panel board, also functions as a maximum fuel flow regulator. Each panel mounts a 0 to 30 psi loading station which "sends" to a positioning device mounted on the valve. The valve, in appearance, resembles a standard plug valve, but instead of a plug has an eccentric swinging gate. The valve is cylinder-operated through a gear quadrant on the valve stem which meshes with a rack fastened to the end of the piston rod. As the piston moves and opens the valve, it compresses a spring. The angular motion of the gear is transmitted to the positioner and the piston takes up a position determined by the loading station. The fuel shut-off is accomplished by de-energizing solenoid valves, shutting off the air supply and bleeding the cylinder head pressure to atmospheric. The valve then closes because of the spring force against the piston head.

The combustion system is designed to handle a maximum heat input of 26,000,000 Btu per hr, of 560-Btu coke oven gas, or an equivalent mixture of coke oven, natural gas and air. For a general arrangement of the combustion system the reader is referred to Figure 4. Each furnace has two thermocouples, one in either end wall. A selector switch is mounted on the panel so that the furnace temperature can be controlled from either couple. As the furnace comes to temperature, the fuel valve remains open until the temperature comes within the proportional band of the temperature controller. The electrical impulse from the strip chart controller, through a proportioning relay, then closes the motor operated fuel valve to meet the temperature requirements of the furnace.

Each furnace has the following control equipment mounted on the panel.

1. Temperature controller and strip chart recorder.
2. Fuel proportioning relay.
3. Waste gas proportioning relay.
4. Fuel-air flow recorder.
5. Air and gas balance indicator North burner.
6. Air and gas balance indicator South burner.
7. Furnace pressure recorder.
8. Multi-point temperature recorder (shared by both furnaces).
9. Fuel-air ratio regulator.
10. Air balancing regulator.
11. Fuel balancing regulator.
12. Furnace pressure regulator.

In addition to the above, there are several push-buttons, indicating lights and a timer, the functions of which will be discussed later. It might be well to mention at this point that all impulse lines from gas orifice plates are ½-in. outside diameter steel tubing and that each orifice in the combustion system has two high and two low pressure impulse lines. One pair of impulse lines goes to a meter or indicator, and one pair to a regulator.

All flow controls, other than the total fuel flow, are hydraulic and operate on the principle of opposing forces acting on an oil stream supplying pressure to a cylinder. There are two separate hydraulic systems, each system serving five batteries. Included in the one system is the main gas control panel which regulates the pressure in the 20-in. gas main at 16 oz. Each system has three gear-type pumps, one of which normally acts as a spare. The hydraulic fluid used is primarily a non-combustible mixture of water, ethylene glycol and a high-viscosity, water-soluble thickening agent. The hydraulic fluid is pumped to the regulators at 100 psi and then gravitates from the regulator to a 400-gallon storage tank.

The combustion air and fuel systems are very similar in that each contains a total flow orifice and a total flow control valve. One pair of impulse lines from the total fuel orifice and one pair from the total air orifice go directly to the fuel-air recorder, while the other pairs go to the two diaphragms of the fuel-air ratio regulator. If the forces caused by the differentials across the diaphragms of the fuel-air ratio regulator are not in the proper ratio, the regulator causes a cylinder to move the total air control valve to a position that gives the proper ratio of forces. After the air and fuel flows divide to the two burners, each branch of each system contains a balancing flow butterfly valve and a balancing orifice. The impulses from the air balancing orifices are placed across the diaphragms of the air balancing regulators. If the flows are not equal, the regulator moves a cylinder operating the cross-connecting air balancing butterfly valves, closing one valve and opening the other. The other pairs of impulse lines go to the air balancing indicators, those from the south branch to the south air-fuel balancing indicator, and those from the north to the north air-fuel balancing indicator.

The fuel balancing system is the same as the air balancing system in that two pair of impulse lines go to the meters and two to the regulators. The balancing valves are cross-connected and operate in the same manner as the air balancing valves.

The furnace pressure butterfly damper is located downstream of the junction of the flues from each recuperator, but before the junction of the waste gas systems from each furnace. The furnace pressure tap is located on the furnace end wall, 3 ft-4 in. below the cover. This pressure and the atmospheric pressure at the furnace are placed over the diaphragm of the furnace pressure regulator. Since the regulator has only one diaphragm, the force caused by the differential is opposed by an adjustable spring loading. If the forces are not equal, the regulator causes the cylinder operating butterfly to correct the unbalance. Again, the other pair of impulse lines goes to a meter recording the furnace pressure.

Special control features—Two departures have been

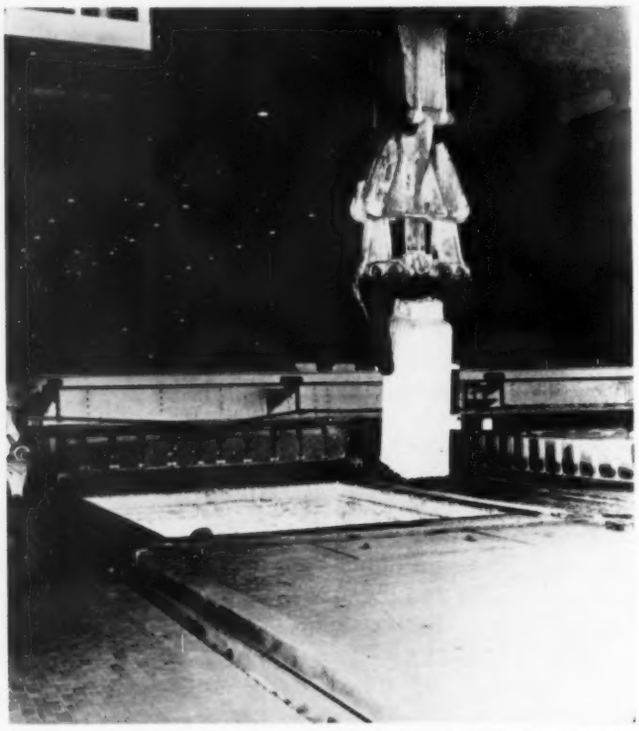


Figure 5 — Three pit cranes and three cover carriages serve the ten 2-pit batteries.

made from conventional soaking pit controls. It is a fundamental fact in heating that the temperature of the surface of a charge of steel lags behind the furnace temperature. If this were not true, heating would be impossible. Also, within the ingots themselves there are temperature differences; in fact, on short track time heats, heating is accomplished by adding heat to the ingot surface and taking it away from the center. The problem of fast heating then reduces to one of bringing the surface of the charge to temperature as quickly as possible or metallurgically desirable, and then allowing sufficient time for the temperature difference within the ingot to equalize.

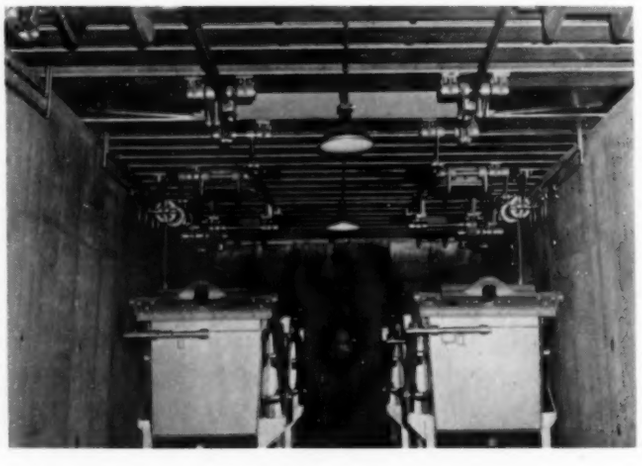
In part, the rate of heating is a function of fuel flow; however, the disadvantage of present heating practices is that temperature control is based on furnace temperature rather than steel temperature. This means that, for a given heat, when the furnace reaches temperature and the fuel-cut-back begins, there may be a large difference between the furnace and the steel temperatures. We must recognize that the fuel-cut-back only indicates a change in the rate at which the steel may absorb the heat and does not indicate that the surface is at temperature. In order to avoid the fuel-cut-back, some operator long ago decided that the thing to do would be to increase the control point 25 to 50 F, and after a certain amount of time, return to the furnace and lower the temperature to the drawing temperature. With this heating practice, if the operator was late in returning, the result was washed or burned steel.

This same type of heating has been accomplished at the Fairless Works soaking pits with automatic controls. We call it "heat acceleration." A second control index and slidewire have been added to a standard temperature controller. Normally the furnace temperature is controlled on the lower or "red" temperature index, but during periods where accelerated heating is required, the lower index slidewire is isolated and the control is shifted to the higher or "green" index slidewire. If heat acceleration is to be correctly applied, it should be used only in bringing the surface of the ingot to temperature. To use acceleration after the surface of the steel reaches temperature would serve only to overheat the surface of the charge and waste fuel. Obviously, the difference between the two index temperatures and the amount of time the control is held on the higher index are of great importance. Operating practice at the Fairless Works has indicated that for best results, the green index setting should be 50 F higher than the red and should be held on acceleration for $\frac{2}{3}$ of the track time, or a maximum of two hours.

To use heat acceleration, the operator must set the green index temperature and set a timer for the amount of time accelerated heating is required. At the conclusion of the heat acceleration cycle, the timer automatically returns the control to the red or rolling index. If for any reason the temperature of the furnace should exceed the setting of the green index, the control is automatically returned to the red index.

The second departure, "flame tempering," provides for the recirculation of waste gases through the combustion air system. Waste gas is drawn from the stack and mixed with the combustion air downstream of the combustion air orifice and upstream of the combustion air fan. Because of the location of the waste gas intake, the recirculation of waste gases does not affect the fuel-air ratio. As the fuel motor closes the fuel valve, after the furnace has reached temperature, a selector switch in the motor energizes the control circuit to the waste gas valve drive motor. This selector switch can be set to start the recirculation at any point during the fuel-cut-back. A second slidewire in the fuel motor operates through a proportioning relay and causes the waste gas motor to open until its slidewire balances the bridge circuit. Therefore, when the fuel flow is at a minimum, the flow of recirculated waste gases is at a maximum. The combustion air fan is capable of continuous operation at 600 F. If the temperature of the mixture of combustion air and waste gases should exceed 600 F, a fan thermal protection switch disconnects the waste gas motor from the proportioning circuit, energizes the close circuit of the waste gas valve drive motor and

Figure 6 — Cinder is removed through four cinder bells and dropped into cinder pit boxes shown.



closes the valve. The net effect of the recirculation of waste gases is to give a higher mass velocity of gases through the furnace during periods of reduced firing, temper the flame and give the benefits of a lean fuel such as blast furnace gas.

Auxiliary equipment—The bottom cinder is removed from the furnace through four cinder bells (Figure 6). The bell closures are operated by pneumatic cylinders actuated by a three-way valve mounted on the walkways between the furnaces. The linkage between the cylinders and the bell closures can be mechanically locked to prevent accidental opening of the bells.

As the cinder leaves the furnace, it is collected in four buckets which are then carried outside the furnace building by two electric lift trucks. The buckets are then hoisted to grade elevation by a mono-rail crane and dumped into a waiting cinder car.

Facilities have also been provided for the handling of coke breeze. The breeze is dumped from the hopper car into a skip car loading hopper below track elevation. The skip then carries the breeze to the top of the storage bin. From the bin, the breeze is poured into the bottom making buckets which can be picked up by the pit crane and carried to the pit. The storage bin is wrapped with steam coils to prevent freezing of the breeze, and a vibrator prevents clogging of the feed chute.

To complete the installation, there has been provided miscellaneous equipment such as tong cooling tanks, bottom making tools, sand storage bins, pit cover repair stands, office and sanitary facilities.

DISCUSSION

PRESENTED BY

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JOHN R. GREEN, Metals Producing and Ceramic Industrial Sales Manager, Industrial Division, Minneapolis-Honeywell Regulator Co., Philadelphia, Pa.

J. L. MILLER, Assistant Chief Combustion Engineer, Republic Steel Corp., Cleveland, Ohio

J. Ward Percy: Mr. Wilt mentioned the combustion volume of the soaking pits. It may not be obvious just what this combustion volume amounts to, so some values may be enlightening. He said the pits were 14½ ft wide by 20 ft long and 15 ft deep, so that actually gives a total volume of around 4400 cu ft. If one foot in depth is allowed for coke breeze at the bottom, that leaves a volume of around 4000 cu ft.

They are 140-ton pits, so subtracting the volume of 140 tons of steel, there remains between 3300 and 3400 cu ft of combustion volume.

I also want to refer to the waste gas flow area of the recuperators, which is stated in the paper as 20.8 sq ft for each recuperator. That gives a total of 41.6 sq ft for each hole, which involves probably an average waste gas velocity of 7.5 fps. Mr. Wilt mentioned that the pits were designed to burn 26,000,000 Btu per hr of 560-Btu gas. Therefore, 26,000,000 Btu, or about 46,500 cu ft of 560-Btu gas per hour, burned in a 3300-cu ft chamber gives around 130 Btu per cu ft per min heat release, which is not high.

It may not be necessary to say anything about the control, but with the twelve separate devices or units that the author mentioned in his list, the control system is complete by present standards.

J. E. Webber: As a fuels and combustion department, instrument repair, and so forth, our feeling about the pits is that they are good pits. They are probably above the average on speed, and we feel that they would be economical to operate under normal conditions.

Now, being the first of the month, I am probably going to be back to the mill for an argument on fuel, which is as it should be, but we have not had what I would call a fair chance to really evaluate the fuel efficiency on these pits. We know that at the beginning, the start-up, we logged and do today during the immediate heating cycle; Btu's per ton ranging from 275,000 to 550,000 without use of waste gas recirculation and approximately 20 per cent more during the recirculation usage.

However, that is based on eight or ten-turn operation. The eight and ten-turn operation have resulted in a fuels charge in the vicinity of 900,000 Btu per ton. I do not know whether that is an out of range charge or not.

We would really like to feel that during the eight and ten turn-operation the shop is stabilized enough to arrive at a factual fuels figure, and know that it is essentially correct. We would like also to see some twenty-turn operations to see what stabilized operations at that pace would be.

We feel that the proper utilization of the controls, that is, the maximum fuel setting, heat acceleration, furnace pressure, excess air, fuel-air ratio, etc., has resulted in a condition which is probably becoming common in the steel industry. The operation of the controls, as such, is getting to a point where during the first year or year and a half of operation, it takes probably more of a fuel or combustion engineer to operate the pits than it does a heater, which is wrong.

I am saying in effect that although we need all of these devices which are on the pits and that they all contribute something to the operation of the pits, it is desirable for instrument companies, control companies and so forth, plus fuel men and control people working for steel companies, to attempt to simplify these equipments in a manner so that an ordinary heater could walk in and take over and start operating the first day.

In this particular case we feel that the operational department has been considerably above the average and they operate the pits essentially the way they were designed to operate.

We have, going a little further in instrumentation, experienced some difficulty with the proper maintenance of our controls. We do not feel that it was either the fault of the contractor or the manufacturer of the controls or the manufacturer of the hydraulic fluid we are utilizing. This probably was a condition stemming from our fuel supply, and the fact that we, going back to my original apologies, have attempted to start so many facilities at once and, therefore, have not put them in operation at the low maintenance figure as soon as we would like to have done so.

We feel that we have found a solution to this difficulty and are looking forward to a period of long trouble-free service on these combustion controls.

S. A. Davis: The most significant fact in our experience in operating the soaking pits at Fairless Works is that the quality of the heating has been good. As to the functioning of the several components, we shall confine our remarks to two features.

We have not been able to derive any noticeable benefit from recirculating waste gases in a number of extensive tests.

Some of the apparatus in the control system for heat acceleration did not perform satisfactorily during the hot weather of last summer, and the difficulties were ascribed to high temperatures in the panel houses. Ventilation was increased, and the supplier replaced certain sections of the control equipment, substituting parts more suited to the higher temperature. These alterations appear to have been effective in making the control system operate properly.

Member: I assume that the walls between the beds are common walls?

Charles R. Wilt, Jr.: They are not. Each furnace has a separate binding, and there is a walkway between the furnaces.

Edward E. Callinan: I would like to inquire about your coke oven usage. Is that dirty gas, and could you also tell me generally what type of control valving you use on coke oven gas?

Charles R. Wilt, Jr.: I do not know that our coke gas is any dirtier or any cleaner here than at any other works. The problem previously mentioned was with regard to the 14-in, recirculation valves. We had two problems there. One was caused by insufficient clearance between the butterfly and the valve body and the other by a deposit from the flue gas. We removed the valves and increased the clearances, but we found that if the valve is not operated, it will have a tendency to stick because of the deposits. This is the preventive maintenance that we were doing at the furnaces.

Our total gas flow valve is a V-port valve. Our gas balancing valves are butterfly valves, and we have in every other case used lubricated plug valves.

Member: I would like a little explanation of how you accomplish this recirculation of waste gases. You seem to take it in ahead of the measuring orifice under vacuum, and the other would be under pressure.

Charles R. Wilt, Jr.: First of all, let me tell you a little bit about the combustion air system. We have below the floor a conical inlet, followed by our total flow orifice, then a flow control valve, which is a butterfly valve. Then we go into a plenum chamber, then a fan, and from the fan we go down to a "T;" from the "T," we split to both ends of the furnace.

Our waste gas is drawn from the stack between the orifice and the plenum chamber. Let me put it another way. It is between the air control butterfly valve and the fan.

We have learned something very interesting about this recirculation in that there is another way of doing it. We are benefitting from that now. We have found that as your fuel cuts back and you reduce your amount of air, you automatically get a proportioning action by virtue of the fan characteristics. As you close the combustion air butterfly, you have more capacity for handling recirculated waste gases in the recirculated waste gas line. The 14-in. valve which was mentioned before is operated by a proportioning motor.

T. D. Clifford: We are making the bottoms on a schedule of every three days now, due to the poor utilization of our pits. There are too many hours that the pits are standing idle, and as a result we are burning the breeze without any steel being placed in them for heating. The pit bottom itself holds approximately five tons of breeze.

Ultimately, when we get into increased turn operation on the mill, we feel bottoms will be made every four days.

Harry C. Paxson: Do you have any idea as to the time that is being lost, with the pit being off, and the actual man hours that are spent in making up the bottom?

Charles R. Wilt, Jr.: We have one bottom maker and one bottom maker helper per turn, and it takes us approximately 30 to 40 minutes to make a bottom including the time required to remove the old bottom.

John R. Green: I would like to make a couple of comments on some of the novelties, so-called, of the control systems that were mentioned, for the benefit of those who are considering their use in the future. Ward Percy mentioned that the idea of double control settings is not basically new. It has been used as far as two control points are concerned for both acceleration, in this case, or what you might call deceleration during holding periods for mill delays. That type of a system can be operated either pneumatically or electrically.

Also, basically, some pit designs have been in operation for some time by what amounts to the same thing, through location of two temperature measuring and control points. These are responsive to the heat head put on the pit, and the waste gases. The latter, unfortunately, are about the best thing that we can approach today as a temperature condition of steel, since it is impossible to continuously measure that average steel temperature by direct means.

To simplify the equipment, as far as the heater was concerned, that same basic idea might be employed as a means of automatically reducing the pit temperature from an exit gas condition, rather than setting it up ahead of time on a timer, based upon track time.

I am wondering whether the records to date have indicated that such an operation would be a possibility?

J. E. Webber: I believe so.

John R. Green: It would remove one of the operations from the heater's hands.

Since this particular job was outlined to be as flexible as possible, not knowing exactly what you were going to require as far as heat acceleration or gas recirculation was concerned, the operations that were placed in the heater's hand might be simplified a great deal by knowing the desired volume in recirculation of gases, and the point of fuel turndown at which recirculation was to be applied.

J. L. Miller: Soaking pits as described to us in this paper are something far from a simple pit. They are ingot heating furnaces. They are pit furnaces. There was a time in the past when we actually put the ingots into a bottom and we did soak them out. However, today you put this steel in and control heat it to the finish.

Today's work is not the same category as was done in the real soaking pit, as we have all manner of controls.

I do want to get this idea across. The title, "The Fairless Soaking Pit," should be the "Fairless Pit Furnaces," since there is complete control on heating, and they are not soaking. You may soak possibly half an hour after the finish, but in all probability, even then there is some fuel in the pit.

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Pittsburgh (22), Pa.

By EDWARD H. D. GIBBS, Contracting Engineer, Heyl and Patterson, Inc., Pittsburgh, Pa.

new ORE BRIDGES at Ohio Works of U. S. Steel

. . . . improvements at the Ohio Works of United States Steel Corp. include the replacement of the two old ore bridges with two new units equipped with 22½-ton buckets . . . . adjustable voltage electrical control was used to obtain the 1640-net ton per hour digging capacity established as the operating requirement . . . . constant potential system would have had difficulty in doing this . . . .

▲ AN ore bridge is a type of gantry in which the span and the legs are articulated so that one leg can move ahead of the other within limits. They are so constructed for several reasons: First, they are often of such long spans that it is almost impossible to keep both ends even; second, it is often advantageous to have the digging end farther up or down the track than the reclaiming end which may be used for loading cars; and third, this design materially reduces the stresses in the span and leg structures over what they would be if all were a single structure.

The two new ore bridges at Ohio Steel works are replacements for two units, built in 1909, which, due to age and limited capacity, can no longer meet blast furnace raw materials handling requirements.

Since 1909 the rated blast furnace capacity at Ohio Steel works has about doubled. This increase in iron production has been accompanied by an even larger increase in iron ore tonnage requirements because of a gradual reduction in iron content of the Mesabi ores. Consequently, the old bridges which were equipped with 15 ton buckets are now being replaced with bridges equipped with 22½ ton buckets which will operate on a much faster cycle (Figure 1). The specified requirement for each new bridge was about 1600 net tons per hour from trench to center of pile, which is a hoist distance of 42 ft and a trolley travel distance of 130 ft.

Investigations indicated that this capacity could most economically be achieved by use of adjustable voltage electrical control of bucket hoist and trolley motions. The calculated maximum, free digging capacity of a 22½-ton bucket bridge with a constant potential electrical system was 1,380 net tons per hour, which was inadequate. This capacity was based on using the largest size AISE mill motors (frame 618) for the hold and close engines.

Some thought was given to the use of two motor drives for each of the two hoisting engines in an effort to meet the required capacity, but this would have resulted in a very heavy trolley having six motors. It would have resulted in a wheel loading or truck length which could not be tolerated.

The use of adjustable voltage control indicated a maximum (free digging) capacity of 1,640 net tons per hour based on the same hoist and trolley travel distances and based also on using the largest size mill motors for the two hoist drives.

In addition to a 19 per cent increase in capacity for only about 9 per cent increase in first cost of the ore bridge there were several other very important advantages of the adjustable voltage electrical system.

1. With this system, high potential (2300 volt, 25 cycle) a-c power is collected from 3-phase trolley wires and carried to the 700-hp induction motor of a motor-generator set mounted on the pier sill of the bridge. This eliminated the d-c collectors which were in an area which is subjected to ground which adversely affect the whole d-c system.
2. It permitted a reduction in the plant d-c conversion capacity requirements. This reduction in

Figure 1 — At time of picture, the 22½-ton ore bridge unit in foreground is complete and operating, and second unit in background is nearing completion.

effective load on this equipment increased its life appreciably at considerable saving.

3. Adjustable voltage system is subject to less maintenance. It does not require the large frequently operating contactors, and because it affords smoother acceleration, does not impose the shock loads on mechanical parts and structure that are found in constant potential systems.
4. It affords much better speed control which is a greatly appreciated operating advantage.
5. Power consumption is only about half that of the constant potential systems which depend on dissipating unneeded energy in resistance. Due to regenerative braking in the adjustable voltage system, there is also some saving due to "pump back" into the plant system.

The span of the bridge between runway tracks is 279 ft. The pier leg to the right is carried on a double rail of approximate standard gage track and the shear leg to the left is carried on a single rail running along the ore pile side of the blast furnace stockhouse trestle. The pier tracks are 15 ft below the shear track.

The bottom of the ore pile is about 24 ft below the pier leg or lowest runway, and the bridge was designed to permit piling to a height of 71 ft above the bottom of the pile. The top of the trolley runway rail is 31 ft above the top of the pile. The bridge is equipped with a 100-ton capacity hopper at the shear leg or furnace side, and this hopper is equipped with two drum type gates capable of loading the ore into cars on either of two tracks. In order to reduce wheel load, one side of this hopper is carried on four idler wheels, and the other side is carried by suspended cables from the top chord of the cantilever portion of the span.

The structure consists of a double "V" type pier leg which maintains the right angle relationship between the span and the centerline of the leg, and which carries the span on four steel to bronze skew plates operating in oil baths. A king pin holds the span in the proper horizontal relationship to the top of the pier leg. The bridge span consists of two 27-ft deep trusses (Figure 2) spaced 22 ft apart on centers and carries two rubber mounted thermit welded 105-lb trolley rails spaced 13-ft 6 in. apart. The shear leg, at the furnace side, consists of a large "A" frame connected at the bottom by a sill which carries the rail clamps and in which is mounted part of the hopper supporting structure. This shear leg supports one end of the bridge on a large modified

Figure 2 — Bridge span consists of two 27-ft deep trusses.

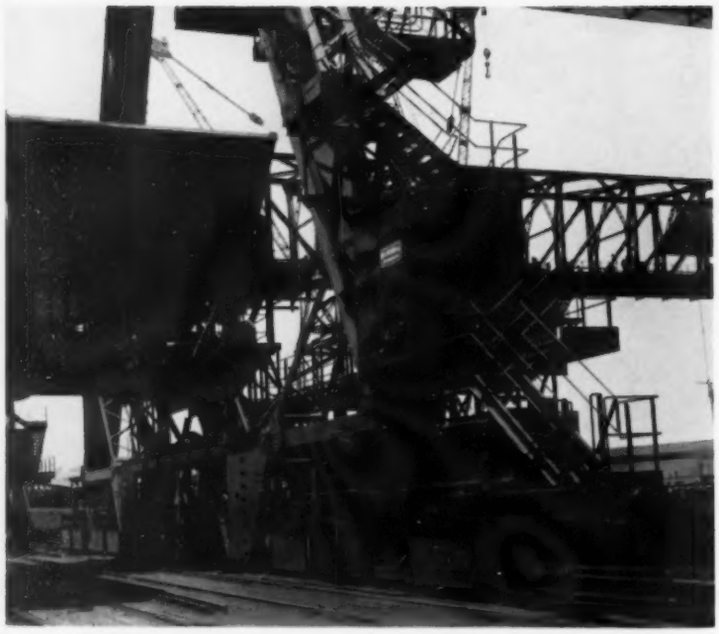
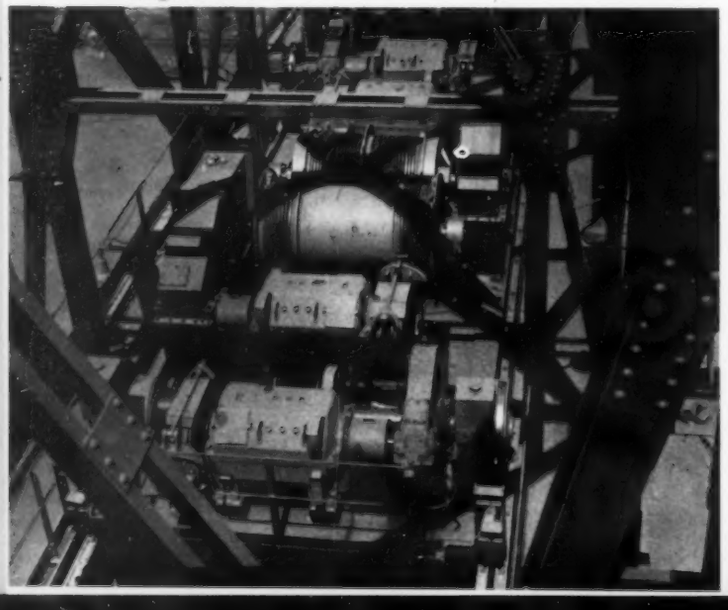


Figure 3 — View shows shear leg, single rail trucks, and 100-ton capacity hopper with two rotary drum gates.

Figure 4 — Pier leg trucks run on double rail. House shelters motor-generator set.

Figure 5 — Trolley has two drives and carries two hoist engine drives.



ball and socket type joint which permits both skewing of the span with relation to the bridge runway and also permits the shear leg to lean in toward the pile as the bridge is skewed. The span was constructed with two seats for the top of the shear leg. These are 30 in. apart and will permit future movement of the leg if the stockhouse trestle is widened. When this occurs, the span will be jacked up and the leg moved over to the new position.

The structure is designed with special attention to the elimination of pockets where dirt and moisture can accumulate. This type of design also provides a clean cut appearance and ease of maintenance painting.

The bridge is mounted on fabricated trucks on a total of 32 wheels, 16 under the shear leg (Figure 3) and 16 under the pier leg (Figure 4). The wheels under the shear leg are arranged in two units—each consisting of four two-axle, two-wheel single rail trucks. The wheels under the pier leg are arranged in two units, each consisting of two four-wheel two-axle double rail trucks.

Power for these bridge drive motors is supplied from the same generators of the motor-generator set that supply power to the hold and close, which are the hoisting engines. This is accomplished by the bridge operator who operates a foot button which automatically transfers the output of these generators to the truck drives. By this means it is possible to obtain the smooth acceleration resulting from the variable voltage control system without the addition of a separate generator to the motor-generator set. Bridge travel speed is about 75 fpm.

The trucks for both pier and shear ends of the bridge are driven by four 100-hp motors, each motor driving eight wheels. The transition from motor to wheels consists of shafting mounted in flexible universal couplings to worm drive units. A spur gear is mounted on the opposite end of the worm wheel shaft and engages the final drive gears on each axle. All gearing is enclosed in oiltight cases. Wheel axles are mounted in bronze bushings and oil from the oil cellars is supplied to the axle journal by means of felt type lubricators.

All wheels (32 in number) are 33 in. diameter, double flange, rolled steel with rim toughened treads and flanges. The total weight of the bridge without ore in bucket or hopper is about 1300 tons. The maximum

Figure 6 — Trolley carries a 22½-ton bucket.

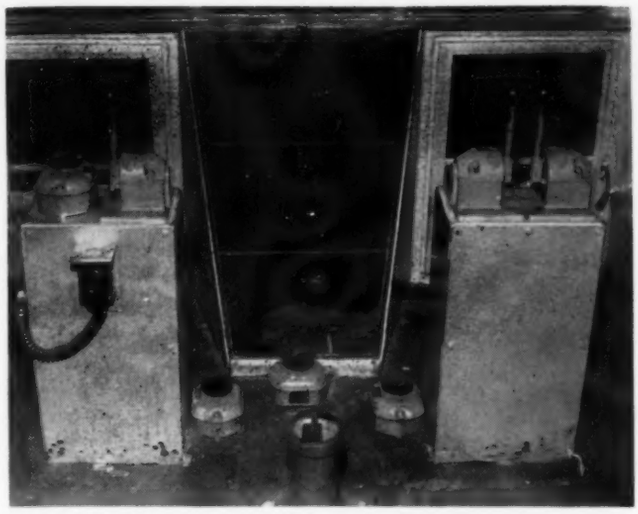


Figure 7 — Operator's position (chair removed) shows all controls necessary for operation of the bucket, trolley and bridge.

Figure 8 — Trolley conductors and collectors are on south side of span.

wheel load on the pier side with the trolley in the extreme position is 95,500 lb per wheel, and on the shear side it is 90,500 lb per wheel. It was considered advisable to go to these higher wheel loads rather than to add additional wheels which would have increased the length of the single rail shear trucks more than could be tolerated. The overall bumper to bumper length of these trucks is 132 ft 9 in., and of the pier trucks 115 ft 6 in. The reason for the extreme length of the shear leg, or furnace end, trucks of the bridge is that it is single rail and it is necessary to support the hopper between the trucks.

The trolley (Figures 5 and 6) is a welded structural steel frame carrying two trolley drives and two hoist engine drives. All four are powered by 250-hp (Frame 618) d-c mill motors. Trolley drive motors are bolted securely to the trolley frame, and the relative motion between the trolley axle and the motor shaft is taken up in an extended coupling from the motor shaft to the pinion of the herringbone gear reduction. Trolley axles are supported in roller bearings which are mounted in special housings incorporating the use of rubber pads to absorb shock.

The bucket has a capacity of 300 cu ft of ore. In the open position it covers an area 7½ by 20½ ft. Bucket hoist speed is 240 fpm, and trolley travel speed is 900 fpm.

The trolley cab is of the two-story type—the top story housing the rotating regulator, and the control for hoist and trolley motions. The operator's position (Figure 7) is in the bottom cab and houses the three master switches which control all motions of trolley, bucket and bridge, and three foot-operated push buttons; one for transferring output of hold and close generators to the pier and shear leg trucks and simultaneously releasing rail clamps, one for the trolley sanding equipment, and one for the trolley brake.

Power and control current for operation of hoist, trolley and bridge travel motions are picked up from nine extruded aluminum conductors running the length of the span (Figure 8), five on one side and four on the other side. Four are power conductors, three are for generator field control, one is for constant voltage (230 v) d-c and one is for bridge travel transfer. This type of conductor saves considerable weight on the span, is rigid, has low contact drop, is relatively easy to install, and is comparatively free from corrosion.

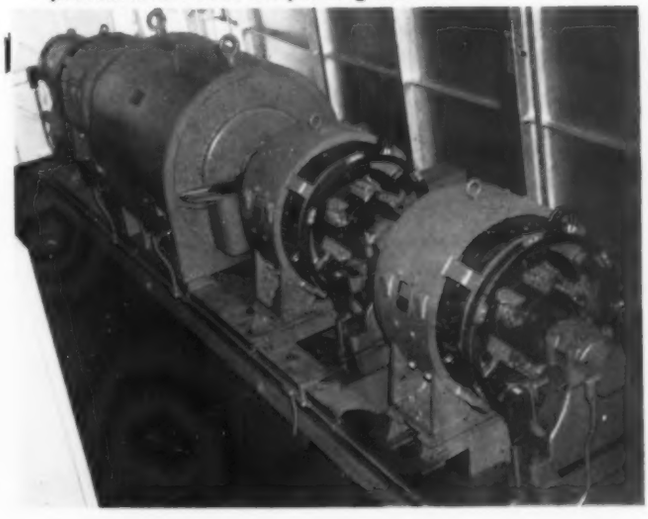
The motor-generator set and its control is mounted in a large totally enclosed house on the pier sill between the trucks. It was possible to locate this house on the sill because there is no necessity for the bucket to pass over this sill. This location permits easy access for maintenance which would not be possible if the unit was mounted on top of the pier leg.

The motor-generator house is equipped with a 20,000 cfm blower which forces filtered air into the house for the purpose of maintaining a slight positive pressure to exclude dust and dirt and also to provide some cooling effect.

This motor-generator (Figure 9) set consists of a 700-hp, 1500-rpm, 2300-volt, 3-phase, 25-cycle motor; two 250-kw, 375-volt, d-c generators for hold and close engine drives; one 400-kw, 395-volt, d-c generator for trolley drives; and one 50-kw, 250-volt, d-c auxiliary generator for power to fields, brakes, rail clamps, trolley lights, trolley cab heater, and repair hoists.

Power at 2300 volts, 25 cycles is picked up from three

Figure 9 — The 700-hp motor-generator set is located in a pressurized house on pier leg sill.



(Figure 8) trolley wires on poles about 30 ft above the ground and brought to the main motor-generator set panel.

This bridge incorporates many features designed to promote the safety of operating and maintenance personnel and for protection of the bridge proper against damage.

Rail clamps—Four rail clamps, each designed with a horizontal holding power of 75 tons, acting with the bridge travel motor brakes, make the bridge stable in winds up to 120 mphr. These four clamps are normally set to hold the bridge stationary. They are lifted by the operator pushing a foot switch which also transfers the output of the hold and close generators to the bridge moving circuit. This foot switch must be held down while the bridge is being moved. Interruption of power supply to the solenoid set and spring released brake of the rail clamp engine allows the wedge type clamp setting weight to lower and set the clamp. These devices are made to "fail safe." The rail clamp circuit is so designed that the clamps will set if: (1) the operator removes his foot from the switch; (2) if the bridge skews sufficient to activate the power skew limit switches; or (3) if the wind at either end of the bridge exceeds 38 mphr from the sides or 45 mphr from the end zones.

Skew protection—Skewing of one of these structures occurs when one leg moves ahead of the other. This is permissable within limits and provisions for skewing is designed into the bridge as previously explained; however, overskewing is one of the principal causes of bridge failures, and protection against this must be positive and certain. Normally the bridge will move so the span centerline is perpendicular to the runway. However, there are times when it may be desired to move one leg ahead of the other to dig out of the trench or to load the transfer car. Also, on long moves, unequal wind pressure may cause one leg to move faster than the other. These conditions result in skewing of the bridge, and the amount of skew or misalignment is limited for physical and structural reasons. A control skew limit switch and a power skew limit switch are provided on each leg to measure the angle between the leg and the span, and to function to prevent damage to the structure. The control skew limit switches provide four steps of slowdown control to the leading leg drives in each direction. The greater the amount of skew, the more the speed will be reduced. This reduction applies to all of the five manual speed points. If the leading leg skews beyond the angle that produces the fourth point of slowdown, a contact will be opened in the control skew limit switch on the leading leg to cause stopping of the travel motors and setting of the travel brakes on that leg. Stopping is also aided by dynamic braking. If the control skew stopping contact should fail to open, and the bridge were to skew farther out of alinement, the two power skew limit switches, one for each leg, will operate to disconnect all power to the travel and rail clamp circuits which will de-energize the motors, set the motor brakes, and cause the rail clamps to set. The operator will require the aid of two helpers to hold the power skew switch contacts closed while the bridge is moved back into alinement. A semaphore type of indicator located at the furnace end of the span which is always faced by the operator, shows him the relative position of both legs at all times.

Anemometer—Two anemometers, one at each end of the bridge, and each located on the top of the legs, are wired in series with the bridge travel control circuits. These units are set to open the bridge travel circuit when the wind has reached a velocity of 35 mphr within a 135 degree zone broadside to each of the two sides of the bridge. When the velocity of the wind reaches 45 mphr in a 45 degree zone at either end of the bridge, it will also open the bridge travel control circuit, which will result in setting of the rail clamps and stopping of the bridge.

Bridge travel overspeed—A speed governor is located on each leg to operate contacts in the travel circuit to disconnect the travel motors, set the brakes, and apply dynamic braking.

Jacking points and protection against broken axles—Bridge travel truck frames are so constructed that the breakage of a wheel or axle will only result in a drop of about one in. The trolley frame is also equipped with lugs which would prevent it from dropping in the event of failure of a trolley axle or wheel. The four corners of the trolley are equipped with special seats for hydraulic jacks to permit easy lifting of the trolley for maintenance purposes.

Trolley buffers—Four hydraulic buffers, two at each end of the bridge span, are installed to stop the trolley at each end of the span, should operator or limit switches fail to function. They are designed to stop the trolley when traveling at full speed and with loaded bucket.

Uphoist limit switches—A limit switch actuated by a weighted rope suspended between the closing lines will stop the upward motion of the bucket to prevent damage to the underside of the trolley.

Sanders—The trolley is equipped with four units for putting sand on the runway rails in the event of wet or freezing weather. These sanders are operated by the foot button in the operator's cab.

Safety gate—The gate on the trolley walkway at the point of access from the bridge structure is equipped with a switch which is in series with the trolley travel control circuit. This prevents movement of the trolley unless the gate is closed.

Stairs and walkways—The bridge is equipped with a very complete system of access stairs and walkways. In accordance with the State of Ohio code, the slope of the stairs is 36 degrees with the horizontal. This stairway system permits access to all operating and maintenance parts of the bridge. There are only four short ladders on the bridge, and these are at each end at the trucks, where there was not available space to put stairs and one each for access to skew semaphone lights and to the service platform at the 2300 volt collectors.

All handrailing consists of two lines of 1-in. solid round bars welded to 2½ x ½ in. bar posts. This railing is easily installed in the field with a minimum of shop fabrication.

These two units are the first adjustable voltage bridges carrying 22½-ton buckets.

PROGRAM

AISE

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AUSPICES

OF

ROLLING MILL COMMITTEE

HOTEL STATLER

DETROIT, MICH.

APRIL 25, 26, 27, 1955

MONDAY, APRIL 25, 1955

8:30 am — Registration — Ball Room Foyer

9:00 am — Rolling Mill Session — Wayne Room

Chairmen: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

Wade F. Hoffman, Superintendent Roll Dept., Jones and Laughlin Steel Corp., Aliquippa, Pa.

"Reversing Hot Strip Mill . . . Its Place in the Steel Production Facilities," by David Lyle, Vice President, Continental Foundry and Machine Co., Pittsburgh, Pa.

"Meeting the Metallurgical Challenge in Rolling Stainless Bars," by P. T. Reynolds, Assistant Superintendent, Bloom, Billet and Bar Mills, Central Alloy District, Republic Steel Corp., Massilon, Ohio, and H. F. Kaiser, Assistant Superintendent 35-in. Blooming Mill, Republic Steel Corp., Canton, Ohio.

"Basic Formulas for Roll Design and Rolling Alloy Steels," by A. M. Cameron, Superintendent, Blooming and Bar Mill Dept., Atlas Steels Limited, Welland, Ontario, Canada.

9:00 am — Mechanical Session — Michigan Room

Chairmen: M. D. Ayers, Chief Engineer, Wheeling Steel Corp., Wheeling, W. Va.

R. A. Kraus, Assistant Superintendent Maintenance, Republic Steel Corp., Chicago, Ill.

"A New Approach to Continuous Mill Drives," by Astor L. Thurman, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Inc., Easton, Pa., and Dieter Hancke, Maschinenfabrik Meer A. G., M.-Gladbach, Germany.

"Composition Bearings Used in Rolling Mills," by Kenneth E. McHenry, Assistant to Superintendent Mechanical Dept., Lackawanna Plant, Bethlehem Steel Co., Lackawanna, N. Y.

"Roll Neck Lubrication," by Herman C. Inlow, Research Chemist, East Chicago Laboratory, Cities Service Research and Development Co., East Chicago, Ind.

2:00 pm — Rolling Mill Session — Wayne Room

Chairmen: James N. Imel, Superintendent Sheet and Strip Depts., Jones and Laughlin Steel Corp., Pittsburgh, Pa.

G. A. Henderson, Superintendent, Rolling Mill Div., Bethlehem Steel Co., Lackawanna, N. Y.

"C. F. and I. 3-Strand High Speed Rod Mill," by V. W. Johnson, Superintendent Rolling Mills and Finishing, Colorado Fuel and Iron Corp., Pueblo Plant, Pueblo, Colo.

"The New High Speed Rod Mill Installed at Continental Steel Corp.," by Don C. Horsman, Assistant General Superintendent, Continental Steel Corp., Kokomo, Ind.

2:00 pm — Electrical Session — Michigan Room

Chairmen: A. J. F. MacQueen, Electrical Superintendent, Algoma Steel Corp., Ltd., Sault Ste. Marie, Ontario, Canada.

R. T. Winterringer, Assistant Superintendent Electrical Dept., Republic Steel Corp., Chicago, Ill.

"New Concepts in Drive Systems for Hot Strip Mills," by R. J. Moran, and H. N. Snively, Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

"Application of Power Data in Selection of Rolling Mill Drives," by A. F. Kenyon, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh, Pa.

"Induction Heating in Tubemaking," by S. O. Evans, Manager of Tubing Operations, Babcock and Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

TUESDAY, APRIL 26, 1955

9:00 am — Rolling Mill Session — Wayne Room

Chairmen: Robert Sergeson, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich.

W. J. Reilly, General Manufacturing Manager, Steel Div., Ford Motor Co., Dearborn, Mich.

"Roll Grinding and Roll Grinding Wheel Application," by William Pope, Direct Factory Representative, National Grinding Wheel Co., Inc., North Tonawanda, N. Y.

"Surface Inspection of Hot Rolled Coil Rods and Bars," by William C. Campbell, Assistant Superintendent, Merchant Mills, Campbell Works, Youngstown Sheet and Tube Co., Youngstown, Ohio.

"An X-Ray Tin Thickness Gage for the Electrolytic Tin Line," by R. R. Webster, Assistant Manager, Metallurgical Research, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

9:00 am — Combustion Session — Michigan Room

Chairmen: F. R. Pullen, Fuel Engineer, Bethlehem Steel Co., Johnstown, Pa.

G. H. Krapf, Division Superintendent Utilities, United States Steel Corp., Chicago, Ill.

"The Application of Tunnel Type Furnaces to Steel Mill Use,"

Part I — **"Mechanical Features and Material Handling,"** by J. T. Cook, Assistant Chief Engineer, Steel and Tube Division, The Timken Roller Bearing Co., Canton, Ohio

Part II — **"Heating and Combustion Features,"** by D. R. Baker, Combustion Engineer, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio.

"Application of Rotary Hearth Furnace for Heating Plate Mill Slabs," by F. C. Schoen, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

"New Annealing Facilities for Ford Motor Co.'s Steel Division," by John Sprague, Fuel and Utilities Engineer, Steel Div., Ford Motor Co., Dearborn, Mich.

HOTEL RESERVATIONS

For hotel reservations, write directly to the Hotel Statler, giving time of arrival, type of accommodations desired and period of stay.

2:00 pm — General Off-the-Record Round-table Discussion — Wayne Room

Chairman: Louis Moses, Mill Engineer, Bethlehem Steel Co., Bethlehem, Pa.

Panel Members: James N. Imel, Superintendent Sheet and Strip Depts., Jones and Laughlin Steel Corp., Pittsburgh, Pa.

Alex Montgomery, Jr., Assistant to Vice President — Rolling United States Steel Corp., Pittsburgh, Pa.

Don C. Horsman, Assistant General Superintendent, Continental Steel Corp., Kokomo, Ind.

Charles W. Barrett, District Manager, Republic Steel Corp., Buffalo, N. Y.

George A. Henderson, Superintendent Rolling Mill Div., Bethlehem Steel Co., Lackawanna, N. Y.

Charles F. Peck, Jr., Assistant Professor, Civil Engineering, Carnegie Institute of Technology, Pittsburgh, Pa.

W. A. Perry, Assistant General Superintendent — Service, Inland Steel Co. East Chicago, Ind.

Topics will include roll breakage, water cooling of rolls, slivers and surface defects in rod production, materials for twist guides, roll neck finishes, main feed and table rollers, slab turndown, determination of roll separation forces. mill housing design for close tolerances.

7:00 pm — Informal Stag Dinner — Grand Ball Room

Speaker: A. E. Kadell, Senior Vice President, Great Lakes Steel Corp., Ecorse, Detroit, Mich.

WEDNESDAY, APRIL 27, 1955

8:30 am — Inspection Trip —

Great Lakes Steel Corp., Ecorse, Detroit, Mich. Buses leave from Hotel Statler.

PLANT VISITS

Great Lakes Steel Corp., Ford Motor Co. and Rotary Electric Steel Corp., have kindly granted permission for individuals attending this meeting to visit their plants on the way to or from the meeting.

Details on this may be obtained by contacting the Detroit District Secretary, O. P. Ashurst, 1000 Marquette Building, Detroit 26, Mich., telephone WOodward 1-2084.

CONFERENCE CHAIRMEN

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Abstracts of Technical Papers

to be presented at technical sessions of

AISE ANNUAL SPRING CONFERENCE

Hotel Statler Detroit, Mich.

April 25, 26, 27, 1955

"REVERSING HOT STRIP MILL . . . ITS PLACE IN THE STEEL PRODUCTION FACILITIES"

by David Lyle, Vice President, Continental Foundry and Machine Co., Pittsburgh, Pa.

DAVID LYLE

▲ NORMALLY the rolling of strip is thought of in terms of the high speed full continuous mill or the semi-continuous mill employing a reversing roughing stand with a continuous finishing train. For high production operations, the modern continuous strip mill is unsurpassed. However, where for various reasons limited tonnages must be considered, the single stand reversing hot strip mill finds its application.

The normal operation of the reversing hot strip mill is discussed. Various operating data are enumerated in an attempt to correlate the general operating practices of this type of mill. Recognizing that proper planning is essential to obtain the ultimate in production from any mill installation, the paper discusses the modern approach for installing the reversing hot strip mill, pointing out recent installations as examples of complete planning.

This paper does not deal with a detailed historical background nor does it go into all the detail design features of the reversing hot strip mill. Rather, it attempts to show that where limited tonnages are to be produced in carbon steels or specialty steels, the reversing hot strip mill comes into its real role in the steel industry. It points out that the capital expenditure for this type of installation for limited tonnage requirements is a factor which cannot be overlooked.

"MEETING THE METALLURGICAL CHALLENGE IN ROLLING STAINLESS BARS"

by P. T. Reynolds, Assistant Superintendent, Bloom, Billet and Bar Mills, Central Alloy District, Republic Steel Corp., Massillon, Ohio, and H. F. Kaiser, Assistant Superintendent 35-in. Blooming Mill, Republic Steel Corp., Canton, Ohio.

▲ CHEMISTRY balance and control of tramp elements of chrome-nickel stainless steel is an important factor for good hot working properties.

Good ingot delivery is essential for good rollability and surface. Proper heating and soaking within close temperature limits is essential on all grades of stainless. Consideration must be given to rate of heating due to the thermal characteristics of these steels.

P. T. REYNOLDS

Blooming mill drafts will vary with each type of steel. Mill speeds are generally slower and less water is used on roll passes to reduce surface cleaning.

There are two types of furnaces used for heating billets for bar mills, continuous and batch type. The later type permits proper heating for small lots and for the more critical grades. All titanium is heated in the batch furnaces.

H. F. KAISER

No major changes in roll pass design have been made for stainless steel bars from $1\frac{3}{4}$ in. round and larger. Under $1\frac{3}{4}$ in. round, some changes are necessary. On stainless sections the drafts are less than for equivalent carbon sections and more pass clearances are necessary.

Skin grinding of all billets between conversions are necessary to maintain surface quality.

"BASIC FORMULAS FOR ROLL DESIGN AND ROLLING OF ALLOY STEELS"

by A. M. Cameron, Superintendent, Blooming and Bar Mill Dept., Atlas Steels Limited, Welland, Ontario, Canada.

A. M. CAMERON

▲ MOST literature published so far on the basic principles of roll design and rolling apply primarily to ordinary steels. Very little information is available on these topics for the rolling of alloy steels. This paper covers this basic data for roll design and rolling of alloy steels and also touches lightly on metallurgy, mill layout and pass design for complicated

shapes. Paper gives details on ingot sizes and shapes. It also develops a basic roll design for a two-high blooming mill to handle highly alloyed steels and discusses the rolling of billets and blooms. Details are given on the roughing and intermediate passes which are considered the most critical part of the mill layout for rolling alloy steels. Finishing passes are described. Items considered include hand rounds, guide rounds, leaders and formers as well as similar data for squares. Designs for rolling square edge and round edge flats are also covered. Information is also given for rolling of small alloy octagon and hexagon bars. The paper also gives and develops a number of basic formulae used by the roll designers.

"A NEW APPROACH TO CONTINUOUS MILL DRIVES"

by Astor L. Thurman, Executive Vice President, Mannesmann-Meer Engineering and Construction Co., Inc., Easton, Pa. and Dieter Hancke, Maschinenfabrik Meer A. G., M. Gladbach, Germany.

ASTOR L. THURMAN

▲ THIS paper presents a survey of some of the basic problems encountered in designing continuous mill drives and the reasons which led to the development of an entirely new type of drive. Following the introduction of this new combination of differential mechanical gearing and variable speed hydraulic units to the steel pipe and tube industry two years ago, operating experience and exhaustive field tests have proven the reliability of this drive under heavy 24-hr mill service conditions.

With such a background the way is now open for application of this drive principle in other types of pipe and strip rolling mills, and also for general use as variable speed units. The possible use of this drive for various rolling mill applications are discussed in the paper.

Complete information is given on the basic features of the two principal drive components, the mechanical differential gear and the oil-hydraulic speed variator unit. General arrangements, load distribution data and speed range selections as well as torque and output curves show the possibilities of various combinations. Special reference is made to speed drop behavior, shock load absorption and methods of regulation.

Photographs and arrangement sketches are included to show different types of drives already in operation and still others which are now being developed. Basic arrangements for continuous tube and pipe mills, continuous hot strip mills, merchant mills, rod mills, and for cold strip mills are given, together with a brief survey of speed and tension control methods.

The basic features of this new continuous mill drive are summarized as follows:

1. Due to the drive arrangement and the resulting load distribution, the total installed horsepower for any given mill is substantially less than it would be when using individual d-c motor drives.
2. Outstandingly rigid speed ratio is maintained at the preselected individual speed of each stand under heavy shock load and frequently changing load conditions.
3. In addition to the possibility of individual speed adjustment for each mill stand, it is also possible to make easily a group speed co-adjustment under load in accordance with any preset schedule by proper control of the speed adjusting units.
4. Lower inertia of the parts to be accelerated or decelerated allows for more rapid governing to suit changing load distribution and conditions of varying speed and/or tension.

"COMPOSITION BEARINGS USED IN ROLLING MILLS"

by Kenneth E. McHenry, Assistant to Superintendent Mechanical Dept., Lackawanna Plant, Bethlehem Steel Co., Lackawanna, N. Y.

KENNETH E. McHENRY

▲ THIS paper will attempt to show why the steel industry has accepted and increased the use of "composition bearings" as a roll-neck bearing in many of its various type mills. With copious amounts of water being applied to rolling mills for cooling purposes, the advent of composition bearings which required only water as a lubricant became a bearing material worthy of experimentation. However, in most applications it was of considerable economic interest to note that the advantage of changing to composition bearings included many or all of the following results: reduced delays, increased production, reduced power consumption, increased bearing life, increased yield, elimination of bearing grease or oil, and improved accuracy of section.

The author briefly describes the construction of the most common composition bearings being used and explains many of their principal properties when this material is being considered for rolling mill bearings. The paper then describes the water used for lubrication and cooling going into detail on the condition, method of application, pressure, etc., to suit various rolling mill applications.

Some of the most successful designs of composition bearings and thrust collars are discussed with the hope that many other rolling mills may find one similar to their application and benefit by applying this type bearing.

This material is not a "cure-all" so consequently the author points out some of the limitations which must be followed to use these bearings successfully. For example, in lubricating composition bearings first keep in mind cooling the journal. Whether it is water soluble oil, oil, grease or a combination of these, always give first thought to coo'ing. Make sure the supply of coolant is constant, and that it does a good job of washing out any sediment or scales.

In conclusion, this paper will summarize many of the general rules which must be followed to successfully apply composition bearings to a steel rolling mill.

"ROLL NECK LUBRICATION"

by Herman C. Inlow, Research Chemist, East Chicago Laboratory, Cities Service Research and Development Co., East Chicago, Ind.

HERMAN C. INLOW

▲ A short history of early practices in lubricating roll necks is given. The more modern practice of using roll neck grease or roll neck spray oil are discussed.

The desirable properties of both roll neck grease and roll neck spray oil are covered. Some of the requirements are: pumpability, extreme pressure properties, grease soap separation under pressure, adhesiveness, etc. The special laboratory test equipment utilized in the development of both of these lubricants are mentioned. These include spray retention tests, pumpability tests, extreme pressure and wear, four-ball tests, etc.

The application method of these lubricants to the roll neck through a centralized system is discussed and some of the problems involved are mentioned.

The economic aspects of roll neck lubrication are included with a comparison of bearing life when lubricated both with roll neck grease and roll neck spray oil. Savings are indicated in quantities used of roll neck spray oil over roll neck grease. The use of roll neck spray oil as a pinion stand lubricant is also mentioned.

"C. F. AND I. 3-STRAND HIGH SPEED ROD MILL"

by V. W. Johnson, Superintendent Rolling Mills and Finishing, Colorado Fuel and Iron Corp., Pueblo Plant, Pueblo, Colo.

V. W. JOHNSON

▲ THE Colorado Fuel & Iron Corp. at Minnequa Works, Pueblo, Colo., put into operation on August 29, 1949, a new, modern, three-strand, high speed, continuous rod mill. This new mill replaces the old hand looping Garrett mill that had been in continuous operation since March, 1903.

This rod mill is a completely new installation, incorporating all the latest ideas and methods, such as; workmen's safety devices throughout the mill; automatic equipment to control and regulate the gas, air and furnace pressures on both the heating and holding furnaces; automatic warning systems of lights and sirens on oil and water pump systems; electronically controlled air pumps for rod switching; new and improved pass design changes for better quality rods. Numerous other applications of the latest mechanical and electrical ideas of the best known designs were incorporated in this installation to make it the last word in modern ideas and designs.

The main building for this mill is 475 ft long by 90 ft wide, considerably larger than is required for a conventional rod mill. There are two furnaces, table roller lines and 27 roll stands in this building, in fact, it can be classified as two mills operating simultaneously as one mill, producing a $\frac{7}{32}$-in. rod from a $4\frac{3}{8}$ in. billet in 27 passes. Actually, it is a four-stand billet mill ahead of a conventional rod mill with a holding or heat restoring furnace between the mills. This is unique compared with conventional designs, and can be classified as a custom built mill, tailored to fit into our other plant facilities. The reason for this unique design was we did not have facilities for producing the required $2\frac{1}{2}$-in. billet economically, not having a billet mill. The rail mill, due to railroad demands, did not have sufficient mill time to roll the required tonnages of $2\frac{1}{2}$-in. billets. However, we did have sufficient mill time on the rail mill to produce the required tonnages of $4\frac{3}{8}$-in. billets to meet all rod mill requirements. This larger billet size lends itself to quick changes with a minimum amount of delay.

The new rod mill when rolling the smaller rod sizes, finishing in roll stand 22 at normal speeds of about 5000 fpm, produces high quality rods in coils or bundle weights of approximately 700 lb. With normal operation, three strands being rolled simultaneously, the 8-hr record on this mill produced 449 net tons of $\frac{7}{32}$-in. rod, equal to 56.12 tons per hour, or 178 mph, or almost three miles per minute.

"THE NEW HIGH SPEED ROD MILL INSTALLED AT CONTINENTAL STEEL CORP."

by Don C. Horsman, Assistant General Superintendent, Continental Steel Corp., Kokomo, Ind.

DON C. HORSMAN

▲ THIS paper discusses the mill layout for Continental's new three-strand rod mill, with use of appropriate illustrations. A discussion of design and operating features of highly automatic mechanical equipment is given, using descriptive slides and covering the performance of such equipment. This includes the mechanical charging beds, three-strand selector switch, completely automatic and untended flying crop shears (one for each strand), safety locking clip shears at each repeater with photoelectric cell and electrical relay timer controls, motor positioned repeater, reel pipe switches and automatically controlled reels, push offs, conveyor transfer, weigh scale and unloading station.

A description is given of the motor drives and special electrical equipment, including precipitation air cleaning system and ventilation provided for such electrical equipment. Slides, charts and graphic meter strips are used to illustrate the type and performance of this equipment.

Pass layouts are illustrated together with a description of the development of rolling schedules and the pass design to facilitate efficient operations. In this respect, the emphasis on the production of quality rods will be stressed, and experimental work to accomplish this purpose will be described with an explanation of the results attained.

Data on the results of using anti-friction roll neck bearings are presented and the use of precision cut gear type couplings are described. Mill speeds and some unusual operating problems encountered, and finishing speeds used for various size rods are discussed.

"APPLICATION OF POWER DATA IN SELECTION OF ROLLING MILL DRIVES"

by A. F. Kenyon, Steel Mill Engineer, Industry Engineering Dept., Westinghouse Electric Corp., East Pittsburgh Pa.

A. F. KENYON

▲ THE methods of power calculations for rolling mills have become quite well established, and test data accumulated for the rolling of steel and non-ferrous metals in all types of mills. Much of this information and data have been reported in previous AISE papers and published in the *Iron and Steel Engineer*.

The present paper deals only incidentally with the detail power calculations for a particular rolling operation, but will develop various ways by which the results of such power calculations may be graphically represented to indicate the influence of different factors on the drive loading, and to show the expected mill performance under different combinations of conditions.

"NEW CONCEPTS IN DRIVE SYSTEMS FOR HOT STRIP MILLS"

by R. J. Moran and H. N. Snively, Steel Mill Engineering, Industrial Engineering Section, General Electric Co., Schenectady, N. Y.

R. J. MORAN

▲ THE modern trend in hot strip mill electrical systems is the use of individual power supplies for each stand of the finishing mills. This trend is made economically possible by realistic evaluation of kilowatts required for maximum utilization of motor horsepower. It was formerly the practice, in common bus arrangements, to supply less than the indicated number of kilowatts on assumption that all stands would not be loaded up to their horsepower rating at the same time. Today, however, the trend is to lower the ratio between theoretical capacity and actual tons rolled so that the diversity factor is now approaching unity. Therefore, the older common bus system loses its chief advantage in favor of the many more advantages of the individual power supply. Among these advantages are:

H. N. SNIVELY

1. Reduction of short circuit currents.
2. Widening of speed cone by voltage control.
3. Simplification of high current bus work and reduction in number of circuit breakers.

For new mills, either individual rectifiers or individual generators can be used for each stand with the economics generally favoring the use of rectifiers. For modernizing existing mills, a combination of generators and rectifiers has been used.

Other new features of modern finishing mills include the use of motor field current regulators and stand speed regulators. The principal advantage of such regulators is the fast, accurate vernier control of motor speed, since the long time constant of the motor field is reduced by regulator "forcing."

For many years, individual d-c roll drive motors have been successfully applied to finishing mill runout tables. Today, the use of individual motors for the roughing mill approach tables, front and back tables, and finishing mill approach tables is extending the benefits of reduced maintenance and decreased downtime to a wider area than ever before thought feasible.

"INDUCTION HEATING IN TUBEMAKING"

by S. O. Evans, Manager of Tubing Operations, Babcock and Wilcox Co., Tubular Products Div., Beaver Falls, Pa.

S. O. EVANS

▲ INDUCTION heating is used for melting, heating tube ends for upsetting, and reheating billets for extrusion in the tube-making facilities of the Babcock & Wilcox Co. The first two of these functions are not too unusual in the steel industry and will be described only briefly. Heating of ferrous billets for extrusion is new and of great interest in the steel industry, however, so a more complete discussion of the installation and its operation will be given.

Induction melting has proven a versatile addition to our steel melting facilities. Small orders of special analyses, where 25 or 60-ton melts are out of question, can be melted in either the 6500-lb or the 1000-lb induction furnaces. The 1000-lb furnace has proved particularly valuable in the development of new alloys.

Induction heating of tube ends for upsetting provides a very high rate of heat input with a resultant sharp line of demarcation between hot and cold zone. This provides strength in the tube wall for gripping to withstand the forces of upsetting. In addition to this, the flexibility of low standby losses and immediate availability of heat is of advantage.

The extrusion installation differs from the previous two in that it is low frequency (60 cycles) and is used for reheating billets for extrusion. It is part of a heating cycle which provides stainless billets in a scale-

free condition to the extrusion press. This is an absolute necessity because scale will result in destruction of the extrusion dies.

"ROLL GRINDING AND ROLL GRINDING WHEEL APPLICATION"

by William Pope, Direct Factory Representative, National Grinding Wheel Co., Inc., North Tonawanda, N. Y.

WILLIAM POPE

▲ THE paper deals with various phases of roll grinding, and it describes in general the various types of conventional roll grinding machines and their function. Other subjects covered are: the grinding wheel; roll material, and quality of surface and finish required on hot and cold strip mill rolls; grinding fluids; wheel trueing and dressing; cutting action and wheel life; and proper wheel selection for specific applications. The grinding of paper mill rolls and rubber covered rolls are discussed. The paper does not go into the manufacturing process of grinding wheels, because the writer feels that this subject has been well covered in numerous articles written by ceramic engineers.

"SURFACE INSPECTION OF HOT ROLLED COIL RODS AND BARS"

by William C. Campbell, Assistant Superintendent, Merchant Mills, Campbell Works, Youngstown Sheet and Tube Co., Youngstown, Ohio

WILLIAM C. CAMPBELL

▲ ABOUT thirty years ago, steel products such as bolts and nuts were, for the most part, hot forged and not subjected to any great stresses in being forged or formed. These products were made from grades of steel such as 1015 and bessemer. Production was not too great and surface defects were not a major problem. However, with the increased production in the past three decades, introduction of automatic equipment, and the increasing quality requirements for new products, steel companies have had to increase the quality of steel that they make.

With the introduction of cold heading and forming equipment, materials were required to withstand greater stresses than that required in hot forging processes.

Surface defects that were not detrimental in hot forging practices became a major problem to steel companies and trades. Among these surface defects were seams, laps, slivers and other mechanical defects. It became necessary to establish additional inspection and control practices to insure quality products reaching the trade.

Various types of testing practice by steel companies are reviewed on hot rolled rod and bars in coil form, for end use in cold heading and cold forming such products as bolts and nuts. Coil rod is material up to and including $47/64$ in. in diameter and coil bar is material $3/4$ in. and over in diameter.

Some of the methods of inspection set up in modern merchant mill practice are as follows:

1. Upset test.
2. Twist test.
3. Etch test.
4. Black light test.

The test practices listed above are reviewed as to their application in merchant mill practice with comments on each as to speed, efficiency, care of product and delays in handling.

It is the purpose of this paper to describe and discuss the benefits of various methods of inspection and test practices.

"AN X-RAY TIN THICKNESS GAGE FOR THE ELECTROLYTIC TIN LINE"

by R. R. Webster, Assistant Manager, Metallurgical Research, Jones and Laughlin Steel Corp., Pittsburgh, Pa.

R. R. WEBSTER

▲ A TIN thickness gage based on X-ray fluorescence of iron has been developed for use in controlling electrolytic tin lines. This is a non-contacting instrument that is mounted directly on the tinning line and makes a continuous recording of the tin coating weight as the tin plate is produced. Measurements can be made with a precision of $\pm$ 0.01 lb of tin per base box. By the use of an internal standard and associated electronic equipment, instrument stability is maintained over an extended period. A sheet model of the gage, of similar basic design, has been constructed for use in the tin mill control laboratory. These gages are capable of measuring several other coatings on steel. With slight modification, certain metal foils and organic sheet materials also are measurable.

The prototype instrument has been in 24-hr-per-day operation since 1951, and installation of similar gages on the remaining electrolytic tin lines at the Jones and Laughlin Steel Corp. is almost completed.

"THE APPLICATION OF TUNNEL TYPE FURNACES TO STEEL MILL USE"

PART I — "MECHANICAL FEATURES AND MATERIAL HANDLING"

by J. T. Cook, Assistant Chief Engineer, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio

▲ THE author's company recently put into operation two furnaces patterned after the tunnel type kilns used

in the ceramic industry. Tunnel type furnaces, while widely used in the ceramic industry, are not generally found in steel mills. The paper describes these furnaces with particular emphasis on mechanical features and methods of handling material.

J. T. COOK

One furnace is used for heating billets for piercing at a seamless tube mill. The hearth of the furnace is made up of a series of moving cars which carry the round billets through the heating chambers of the furnace. The billets are loaded on the cars in the furnace with an automatic charging machine and are removed by a manually controlled dicharging machine. The furnace is designed for a maximum heating rate of 40 tons per hour.

The method of handling the furnace cars is unusual. A return tunnel is provided under the furnace for returning the empty cars from the discharge end. Elevators are provided to lower the empty cars to the return tunnel at the discharge end and to raise them to the furnace level at the charging end.

The operation of this furnace for a period of about a year and a half indicates that the tunnel type furnace is well suited for heating tube rounds for piercing.

The second tunnel type furnace is used to anneal various sizes of tubing, billets, and bars. It more closely follows the design of the tunnel type kiln. The cars are loaded and unloaded outside the furnace. The furnace itself is 175 ft long and will anneal about five tons per hour.

The furnace is located in its own building away from the main plant, but adjacent to an outdoor storage yard for steel. A fork truck is used to bring steel into the building and to load and unload the furnace cars. The truck is also used to move the furnace cars from the discharge end back to the charging end of the furnace.

This furnace which has been in service about six months has given good results in annealing and has required a minimum of manpower for operation.

PART II — "HEATING AND COMBUSTION FEATURES"

by D. R. Baker, Combustion Engineer, Steel and Tube Div., The Timken Roller Bearing Co., Canton, Ohio

D. R. BAKER

▲ IN order to obtain the desired quality of a heating furnace for large tonnages and sizes of steel that would occupy limited space and existing building layout, it was decided to build the first car type straight tunnel type furnace. This presented many additional mechanical problems resultant from the rate of heating necessary with the minimum fuel consumption. The furnace had to be equipped with burners and fuel input to obtain a heating rate of 15 minutes per inch of diameter of the billets to obtain the 40 tons per hour. Effective heat seals had to be designed at charge and discharge ends as well as on the sides and ends of cars, and the cars had to be rapidly transferred to obtain minimum heat loss.

The second straight car type tunnel furnace was built to obtain a continuous flow of large bundles of tubing and solids through any of four annealing cycles. Uniform heat distribution in a mass was the prime consideration, especially during the variable cooling rates with varying loads per car. There are 172 burners evenly spaced firing on top and under the load to obtain the desired flexibility of operations. It is fully automatically controlled and equipped with extensive safety shutoff equipment requiring the minimum amount of attention for the staff of two men who load and unload this furnace.

"APPLICATION OF ROTARY HEARTH FURNACE FOR HEATING PLATE MILL SLABS"

by F. C. Schoen, Chief Engineer, Alan Wood Steel Co., Conshohocken, Pa.

F. C. SCHOEN

▲ THE modernization of Alan Wood Steel Co.'s 84-in. plate mill included replacement of existing heating facilities consisting of six batch-type furnaces. An intensive study was made of various types of continuous furnaces and rotary furnaces, with particular reference to their ability to handle a wide range of width, thickness and length of slabs. The study also included material handling, space limitations, manpower requirements, and ease of installation with minimum shutdown of existing production facilities, as well as, estimates of cost for complete heating and material handling installation.

The final arrangement of equipment, consisting of depiler, cold slab conveyor, charging and discharging mechanism and rotary furnace, is described (with illustrations) with particular emphasis on those items peculiar to the needs of the Alan Wood installation. During the construction of foundations and erection of 90 per cent of the equipment, the loss of production facilities was held to less than 25 per cent. The final installation then took place during a three week period when the entire department was out of operation.

A number of problems arose after the start of the furnace operation which required changes in scheduling methods as well as mechanical changes and adjustments in order to fully realize the capacities of the new equipment. Present results of continuous heating with rotary hearth furnace are reaching expectations, and few if any details of the original planning would be changed for future installation.

APPLICATION FOR MEMBERSHIP

Date_____

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Immediately upon notification of such admission, I promise to pay fees (in U. S. funds) as required:

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Association of Iron and Steel Engineers, Empire Building, Pittsburgh 22, Pennsylvania

Stability of Lubricating Greases in centralized lubricating systems

By ELDON L. ARMSTRONG
and
CHESTER D. THAYER
Socony-Vacuum Laboratories
Technical Service Dept.
Brooklyn, N. Y.

. . . . performance of a grease in a centralized lubricating system is definitely affected by oil separation . . . . type of soap, amount of soap, viscosity of mineral oil, and processing. . . . all affect separability characteristics . . .

▲ IN the selection of a grease for use in a centralized lubricating system, there are two important points to be considered.

1. The grease must be the best grease for the application, i.e. it must furnish satisfactory lubrication, as well as fulfill any other duties, such as sealing, rust protection, etc., required of the grease.
2. It must resist separation into its two basic components — thickener and oil.

The selection of a grease to satisfy the first of these requirements is dictated by the speed, operating temperature, load and design of the part to be lubricated. Wet conditions or dirty atmospheres may impose further demands on the grease. However, the solution of this problem is outside the scope of this paper. Here we will be concerned with the second requirement.

All greases will separate oil to a certain extent under conditions conducive to pressure filtration. For those unfamiliar with pressure filtration effect, it can be illustrated in the simplest form by the old fashioned grease cup. In this device, pressure is applied to the surface of the grease. This pressure is supposed to force grease through the capillary to the bearing. What happens with many greases is that oil rather than grease is delivered. Eventually a hard mass of soap accumulates in the grease cup. This same sort of separation occurs in centralized lubricating systems. In most centralized lubricating systems, the pressure necessary for the distribution of the grease is maintained by gaskets or small clearances between the moving parts. These clearances act as filters that will collect solid or semi-solid material.

Figure 1 — The original S/V separability test was designed to stimulate conditions which cause oil separation in spring loaded grease cups.

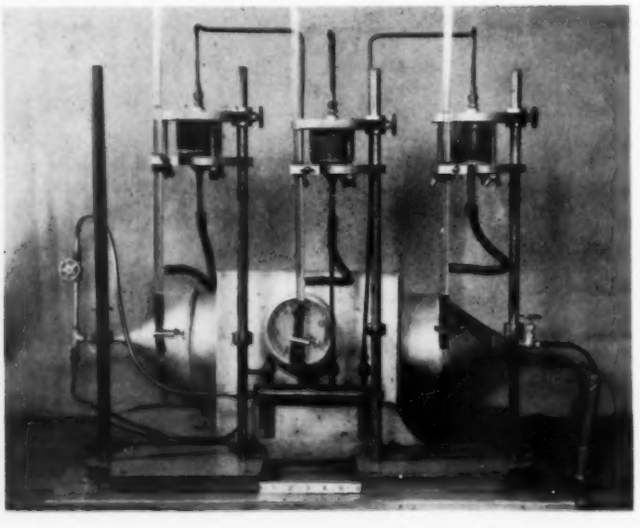
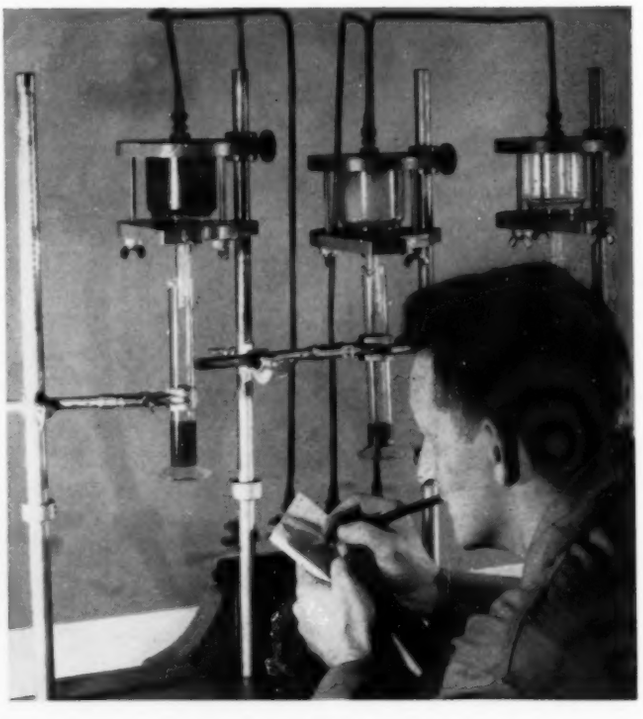


Figure 2 — View shows the modified separability tester.



In most cases faulty operation of a lubricator can be traced back to material of this type. It will become evident by erratic operation of the lubricator, or the system will cease to function altogether.

There are two possible sources of this troublesome accumulation. One is contamination of the lubricant. This is a matter of proper care and handling of the grease and is not related to the grease itself. The other is the susceptibility of the grease to separation into its basic components — thickener and oil.

If a grease is susceptible to separation, it will leave residues of the thickener, or at least thickener concentrates, which will clog the metering device. The rate of build-up of such residues to the point where they become troublesome is dependent on a number of things. First, the design of certain systems are more conducive to pressure filtration than others. Second, if the amount and frequency of application of the grease are great enough, any objectionable residues will be flushed away

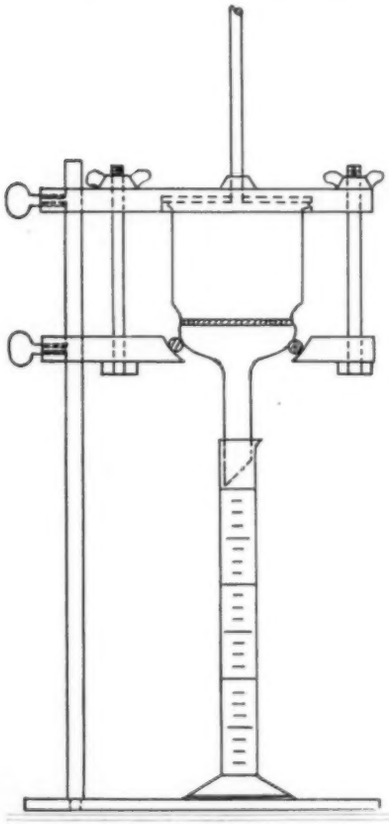


Figure 3 — In the test, sample of the grease is held on a porous plate and subjected to a pressure of 7.5 psi.

or purged from the system before their build-up causes any operational difficulties.

Greases do not have the same susceptibility to pressure filtration or separability. There are various factors, such as the type and amount of soap, viscosity of the mineral oil and method of finishing, that enter into the manufacture or composition of a grease that influence both rate and amount of oil separation. To eliminate costly field trials, it is desirable to have a test to screen out those greases which might cause difficulties in a centralized lubricating system.

Such a device is available in the S/V separability tester (Figures 1 and 2). This test equipment was originally designed to simulate conditions that caused oil separation in spring-loaded grease cups. See "Separability Characteristics of Lubricating Greases," NLGI Spokesman 1945. In the survey of available test equipment that would be suitable as a screening device for greases to be used in centralized lubricating systems, it was apparent that this tester should be adaptable for this purpose. Our preliminary test work showed that the correlation of laboratory test results with field reports on the performance of various greases in centralized lubricating systems was excellent. In other words, those greases which were satisfactory for use in centralized lubricating systems showed lower rates and amount of oil separated than those where field tests were poor.

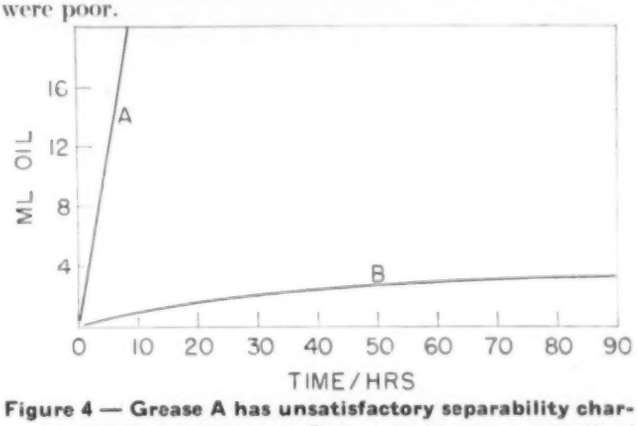


Figure 4 — Grease A has unsatisfactory separability characteristics and grease B is suitable for centralized systems in steel plants.

In the S/V separability test (Figure 3), a sample of grease is held on a porous plate and subjected to air pressure of 7.5 psi. The amount of oil forced through the porous plate and the rate at which it emerges are measured. Typical data showing greases with high and low separability are shown in Figure 4.

Grease A is a typical ball and roller bearing grease of an NLGI No. 2 consistency while Grease B is an extreme pressure grease of an NLGI O consistency. When grease A is used in a lubricating system, objec-

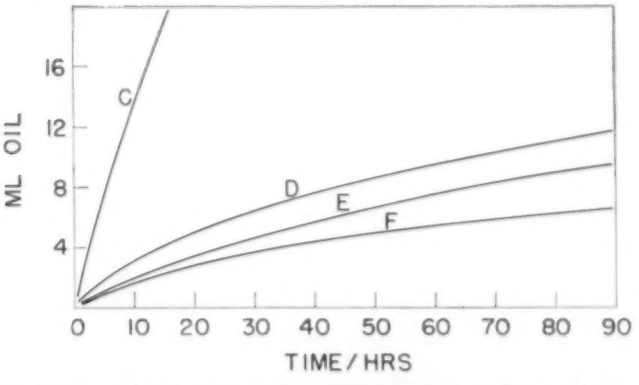


Figure 5 — Soap types have a definite effect on separability.

TABLE I

Effect of Soap Type on Separability*

Grease	Consistency @ 77 F	Type of soap	Per cent soap	Mineral oil viscosity SUS @ 100 F	Ml oil separated in 100 hr
C	Semi-fluid	Sodium	4.5	750	40 (60 hr)
D	315	Lithium	10.0	750	13.8
E	345	Lime	10.0	750	10.2
F	315	Lime lead	10.0	900	7.0

*Characteristics of greases in Figure 5.

tionable soap residues will develop. Grease B has been used successfully for years in centralized systems in the steel mills.

Now some of the factors that influence the rate and amount of oil that will separate from a grease will be discussed.

In Figure 5 are shown typical separability curves for greases of various soap bases. The characteristics of these greases are shown in Table I. It will be noted that the soda soap base grease shows the greatest amount of oil separation while there is no marked difference in that of the other three soap bases. This difference can be explained on the basis of the size of the soap particles present in these greases. In the case of the soda soap greases, the soap particles are large and the oil is loosely held. It is, therefore, comparatively easy for oil to be forced from the grease mass. In the case of the other greases, the soap particles are much smaller and the oil is retained more tenaciously in the grease mass.

The rate and amount of oil separation is influenced by the amount of soap in a grease. Usually the amount of separation and the rate will be lower for the grease containing the greater amount of soap.

In Figure 6, are shown three greases differing only in the amount of soap illustrating this effect. The characteristics of these greases are shown in Table II. It will be noted that an increase of 4 per cent in the soap concentration more than cut in half the amount of oil separated from the grease in a 90-hr period. This would seem to indicate that a firmer, or higher soap content grease would be the best choice to eliminate oil separation. However, there are practical considerations of pumping pressures that limit the use of such greases.

In Figure 7 are shown two greases which differ only in the viscosity of the mineral oil component. The

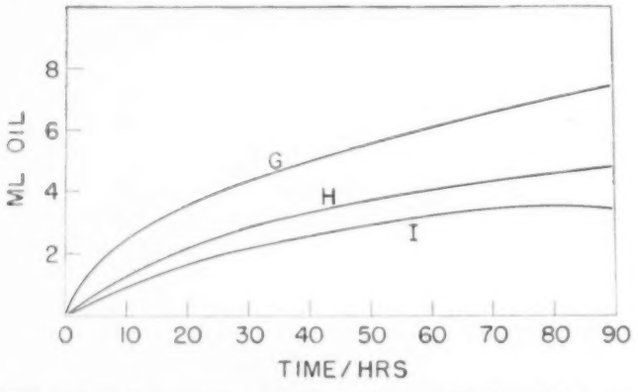


Figure 6 — Soap concentration has a definite effect on separability.

TABLE II

Effect of Soap Concentration on Separability*

Grease	Consistency @ 77 F	Type of soap	Per cent soap	Mineral oil viscosity SUS @ 100 F	Ml oil separated in 100 hr
G	335	Lime lead	13	750	7.9
H	305	Lime lead	15	750	5.0
I	270	Lime lead	17	750	4.0

*Characteristics of greases in Figure 6.

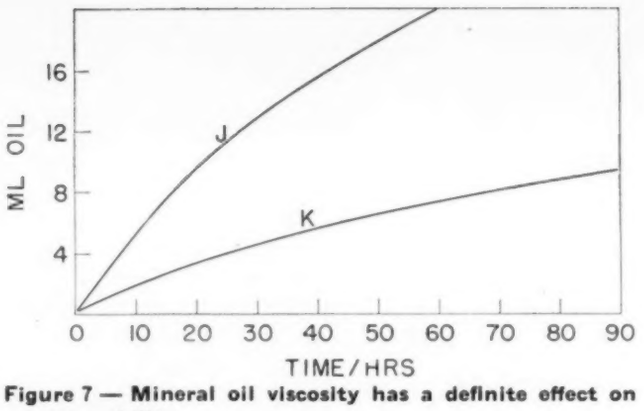


Figure 7 — Mineral oil viscosity has a definite effect on separability.

TABLE III

Effect of Mineral Oil Viscosity on Separability*

Grease	Consistency @ 77 F	Type of soap	Per cent soap	Mineral oil viscosity SUS @ 100 F	Ml oil separated in 100 hr
J	335	Lime	11	100	30.4
K	345	Lime	10	750	10.1

*Characteristics of greases in Figure 7.

characteristics of these greases are shown in Table III. This illustrates the reason why in the selection of a particular grease it is advisable to pick the one with the higher viscosity oil.

Earlier in the paper when discussing the effect of soap type on the separability characteristics of a grease, it was brought out that the size of the soap particle influenced the amount of oil that would separate from a grease. In Figure 8, the effect of the size of the soap particle on separability is illustrated. These two greases are the same in formulation, the only difference being in the finishing treatment during manufacture. Grease L was finished in the conventional manner, while an additional step was used on Grease M. This additional step was one of homogenization in which the size of the soap

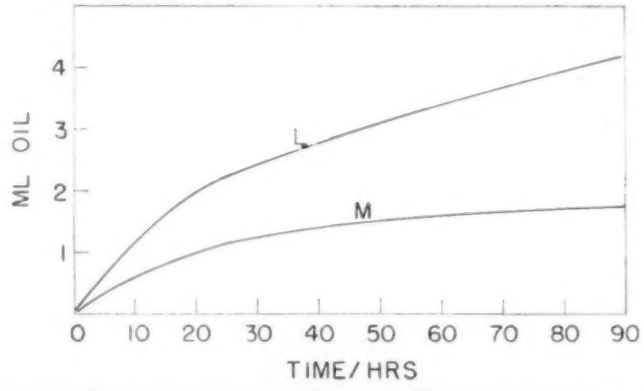


Figure 8 — Homogenization has a definite effect on separability.

particle is reduced by shearing action. These smaller particles have a more retentive grip on the oil in which they are dispersed. This retentiveness is shown by the much lower oil separation in the case of Grease M.

In conclusion, we might mention that in addition to the usefulness of the S/V separability tester for screening greases as to suitability for use in centralized lubri-

cating systems, this tester is under consideration by one of the Subcommittees of Section II, D-2 of the ASTM. In this case, it is being used to predict the tendency of greases to separate oil in storage. This increased interest in the tester has prompted us to consider redesign of the equipment. In one new design, the glass filter funnel is replaced with a brass chamber containing an alundum disc. This makes for a simpler set-up and eliminates the problems of cleaning the sintered glass disc of the old design. In this new design, the intention is to discard the alundum disc at the completion of the test, or possibly to accumulate the discs and clean them in a large batch. The results obtained with this modified S/V separability test are essentially the same as obtained with older designs. Greases are rated in the same order as to separability characteristics.

As shown in the data presented, there are a number of factors which affect the oil separation characteristics of greases. In the order in which they were discussed these are:

1. Type of soap.
2. Amount of soap.
3. Viscosity of the mineral oil.
4. Processing.

This oil separation has a marked effect on the performance of a grease in a centralized lubricating system.

To summarize, data has been presented showing the utility of the S/V separability tester as a device to evaluate the stability of lubricating greases in centralized lubricating systems.

TABLE IV

S/V Separability Data Used in Paper

Grease	Ml oil separated							
	5	10	20	40	60	80	100	120
A	11	23	55	—	—	—	—	—
B	—	1	1.7	2.3	2.8	3.2	3.6	4.0
C	7.2	13.8	22.5	32.5	40	—	—	—
D	—	3.0	4.9	7.3	9.3	13.0	13.8	14.7
E	—	1.8	3.3	5.6	7.5	9.0	10.2	11.0
F	—	1.6	2.9	4.4	5.4	6.2	7.0	7.7
G	—	2.4	3.5	4.8	6.0	7.0	7.9	8.7
H	—	1.3	2.1	3.3	4.1	4.6	5.0	5.4
I	—	0.9	1.6	2.5	3.2	3.5	4.0	4.4
J	—	5.4	9.4	15.4	20.0	25.5	30.4	35.6
K	—	1.9	3.3	5.6	7.3	8.7	10.1	11.4
L	—	1.2	2.0	2.7	3.3	3.9	4.5	5.0
M	—	0.6	1.0	1.4	1.6	1.7	1.8	1.9

DISCUSSION

PRESENTED BY

ANDREW E. CICHELLI, Lubrication Engineer, Construction and Engineering Depts., Bethlehem Steel Co., Bethlehem, Pa.

CHESTER D. THAYER, Technical Service Dept., Socony-Vacuum Laboratories, Brooklyn, N. Y.

JOSEPH S. AARONS, Lubricants Chemist, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

EDWARD M. DOWNS, Technical Assistant to Lubrication Engineer, The Timken Roller Bearing Co., Canton, Ohio

WALTER H. HODSON, Sales Manager, The Hodson Corp., Chicago, Ill.

ROBERT T. DAVIDSON, Special Representative, Industrial Products Dept., Sun Oil Co., Youngstown, Ohio

Andrew E. Cichelli: Does any correlation exist between the separation test in the laboratory and the performance of the same grease as a lubricant? From our standpoint it is important to know whether oil separation tests in the laboratory correlate with a grease's ability to lubricate a bearing.

The authors implied we are using greases that are compromises. This situation is forced upon us by the fact that though bearing performance is our first consideration, all of us are saddled with conditions in the field that make it very difficult for us to use what we consider to be the right grease in the bearing, and at the same time be sure it reaches the bearing to do its job.

By this remark, of course, I am referring to two other considerations, the design of the system, and the design of the bearing, which in our opinion are just as important as the separation problem.

I think I can go back about 10 years at least, and say that we have had no major difficulties with oil separation. I know we could not have been so fortunate, had we not designed around weaknesses of the grease system and made some modifications in our bearings.

Secondly, one must be sure that whatever method one uses to deliver grease to the bearing is foolproof and reliable. All of us must learn how to get the most out of the various systems on the market.

Finally, since a bearing is of first importance, once we have found a satisfactory grease, we ought to give the grease every opportunity to do its job. That means the bearings must be so designed that ample lubricant is available as needed in the right place and the right time.

Chester D. Thayer: Mr. Cichelli brought up two questions: "Have we checked laboratory evaluations against field performance?"

In Figure 5, grease C showed very high oil separation This grease has been tried a number of times in centralized systems. Invariably, the systems become inoperative when the frequency of application and the amount of grease supplied were low. Metering blocks from such systems have been examined in our laboratory, and we have found soap concentrations on the voids to be the cause of failure. These deposits contained five to seven times the amount of soap normally present in the grease. In other words, grease C is not suitable for use in these systems on the basis of field performance and from the results of laboratory tests.

"Does the laboratory test correlate with the ability of the grease to lubricate the bearing?"

No attempt has been made to obtain such a correlation. We contend that a grease should be selected on the basis that is the best lubricant for that application, and not on the basis that the grease is the easiest to handle in the centralized system which is to deliver it to the bearing. In other words, adequate lubrication should not be sacrificed for ease of handling. Our test is only intended to show that the use of certain types of greases may cause operational difficulties in a centralized system. If these potential problems are recognized, they can be compensated for in various ways. As

brought out by Mr. Cichelli, changes can sometimes be made in the bearings to compensate for the deficiencies of the delivery system, or as previously mentioned the frequency and amount can be increased to reduce the potential difficulties.

Andrew E. Cichelli: I am trying to make a point that just because the grease separates, it has not been established it will give you trouble in the bearing. If the grease would separate in the system though it performs well if it reaches the bearing, it would seem we have a job to do in making corrections to the system.

Chester D. Thayer: We have that problem all the time.

Joseph S. Aarons: The stability of lubricating greases in centralized lubricating has been of great interest to us and we have adopted a test which is quite similar to the one just described. Messrs. Thayer and Armstrong have very ably presented the features.

The equipment used at the United States Steel Lubricants Testing Laboratory has been adapted to the test used at the laboratory of the Standard Oil of New Jersey and consists of a Standard Oil Development or S.O.D., pressure size cylinder with pistons and two-threaded heads.

The filter unit is made up of two steel rings with brass perforated disc soldered to them. The perforations are of 500 mesh size, six allen set screws hold the disc firmly to one of the threaded heads. A piece of No. 1 filter paper is used to separate each disc and to insure against any grit pushing past above the bridge. The filter unit is then screwed into the cylinder and tightened. A sample of grease, approximately 50 grams, is charged to the cylinder and the piston or foil plate is then adjusted. The cylinder is then attached to a vertical post and connected to a nitrogen gas cylinder with flexible hosing and flexible regulator. A glass beaker is put under the base to collect any separating oil. A pressure of 100 psi is built up in a two to three minute period, since a sudden surge of pressure will sometimes tear the filter paper.

At the end of 22 hr, the amount of oil in the beaker is weighed. The result is expressed in grams rather than in per cent, because most of the separation takes place from the grease near the bottom and is independent of the grease charge.

The author's method differs from ours in a few respects, namely, a 7½ head was used instead of 100 psi of nitrogen. Second, the sample holder is larger and more samples surge to the pressure action. Third, longer periods of time for tests are apparently used. However, we could continue ourselves out to 90 or 100 hr, as the case may be. A volume measurement is used instead of weight measurement. However, all the points brought out by the paper have been either in part or totally corroborated at the United States Steel laboratory. As an example, mention can be made of work done in a group of calcium bases of No. 1 consistency, having a soap content of 10½ to 12 per cent and oil viscosity of 100 to 1300. In the majority of cases, the oil separation was higher where the viscosity was lower.

There was one point which I would like to bring out, which may be of interest. In this filter assembly, they had for our test, we find a small amount of sample, up to a thickness of one-quarter inch, which resembles quite closely the separated thickener mentioned in the paper. This material can be placed in various stages of hardness, with no correlation between oil separation and hardness of the thickener having been made as yet. Possibly the effect of pressure even with low oil separation will show a tendency for some greases to harden excessively. Have the authors noted this condition in any of their work?

Chester D. Thayer: As I understand your question you are thinking of the effect of the pressure on the grease. In other words would the grease harden due to pressure exerted on it without any expulsion of oil from the grease structure. Possibly under the higher pressure (in excess of our 7.5 psi) that exist in centralized systems, some greases might undergo structural changes, but we have not investigated this matter.

Joseph S. Aarons: This may be a hardening feature of the grease, possibly.

Chester D. Thayer: The soap concentration will build up on the surface of the porous plate.

Joseph S. Aarons: Have you run into any of the greases which possibly have low oil separation that would show a tendency to reharden?

Chester D. Thayer: No. We have found some metering blocks that have been sent back to us in the laboratory, where the soap content has increased two to five times the original amount of grease. That is the deposit shows that. We removed a ⅛-in. layer, which is in contact with the filter plate, and we find the soap content of that layer is approximately 2 to 5 times that of the original grease. If you have a low separation such as we showed on the last two greases, there will be no increase in that layer.

Edward Downs: What was the approximate amount of grease used in your apparatus?

Chester D. Thayer: 150 grams.

Walter H. Hodson: Did you conduct tests on mixed basis or variations from just what you have shown?

Chester D. Thayer: We have tested other greases than what we have shown here in our paper. We have a complex lime grease that shows very low separation.

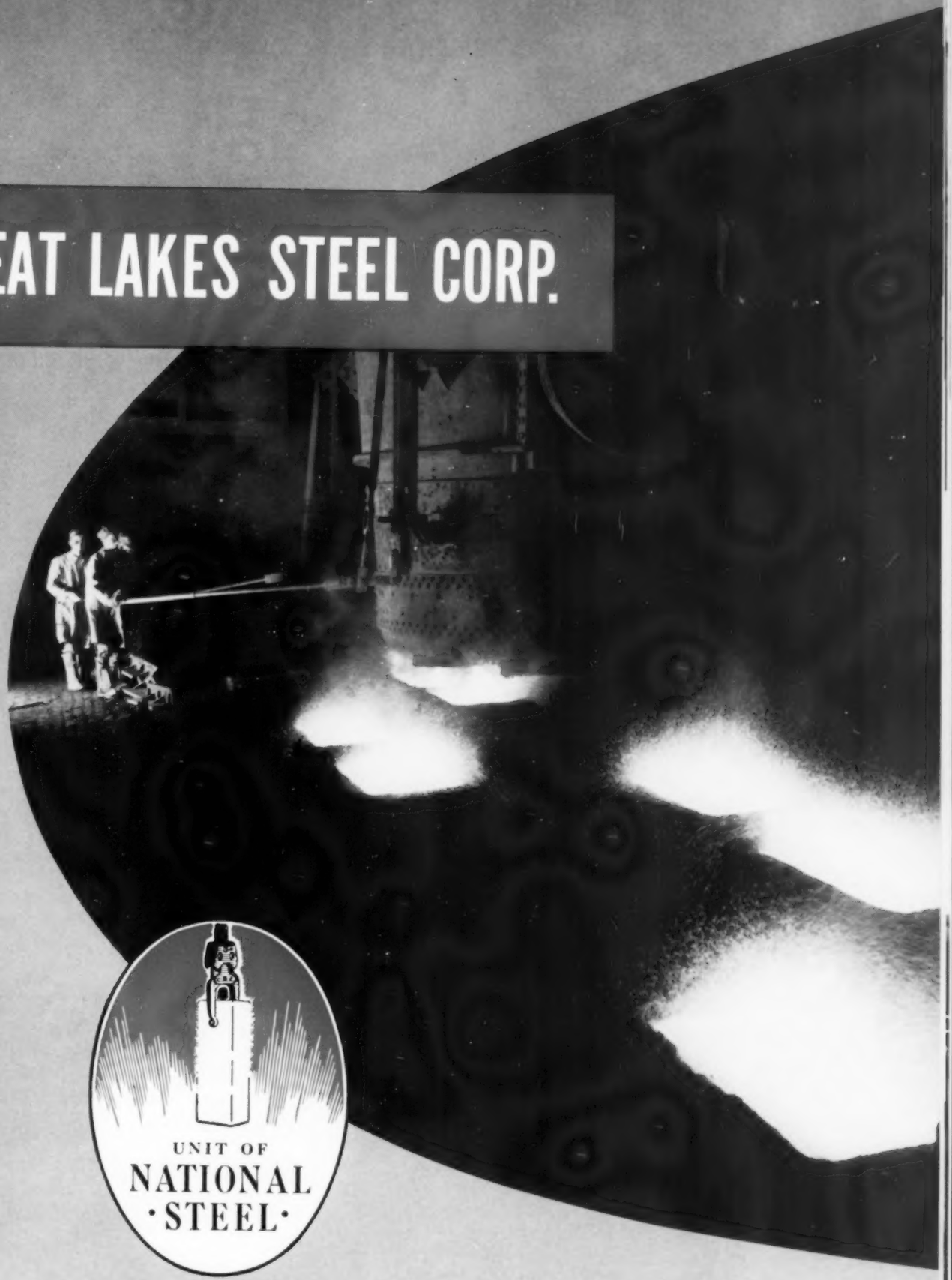
Robert T. Davidson: I have been trying to assimilate information on this subject for the last few months. One of the theories propounded by one of the manufacturers of lubricating equipment is that the results of this separation test extended into ultimate use applies only to a centralized system where the grease is applied at relatively long intervals. If the grease is fed constantly, this separation condition does not occur.

I can visualize that the concentration of soaps might affect pumpability. Have you through this separation test been able to correlate its results into any pumpability trend?

Chester D. Thayer: As was brought out in both the paper and earlier discussion, it is possible to eliminate soap concentrations or deposits by increasing the frequency of lubrication and the amount of grease supplied. If a grease has a tendency to separate, the troubles that might result from such separation can be reduced by these steps. The separation still occurs but is a milder form, and any deposits are flushed from the system before they can cause trouble.

In answer to the second question as to the effect of separation on pumpability, it will usually be apparent by the increase in the pressures required to deliver grease if deposits are accumulating.

GREAT LAKES STEEL CORP.



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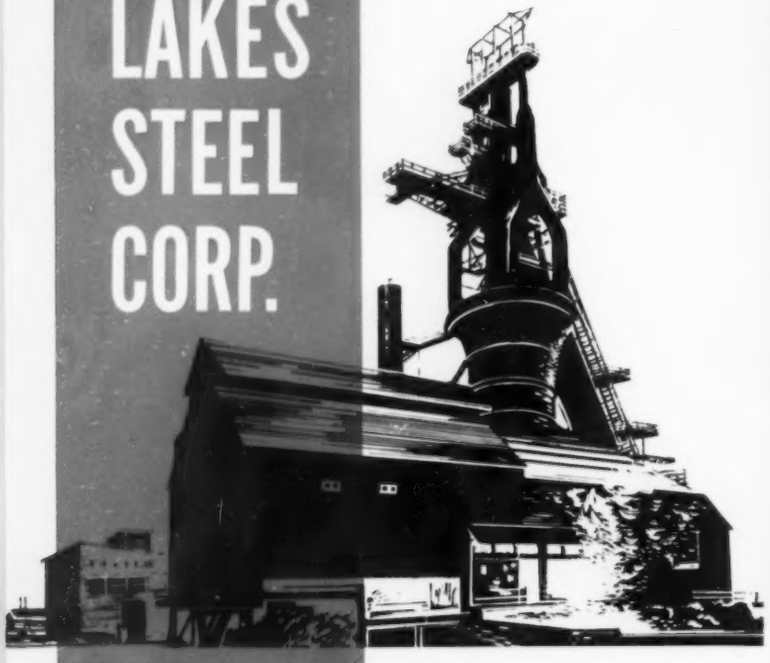


Aerial views of steel plant (top) and blast furnace division.

By T. J. Ess

▲ IF a steel man were to sit down and dream about an ideal location for an integrated steel plant, he would think in terms of availability of raw materials, low-cost transportation, power and water supply, and, of course, proximity to markets. Actually, he would probably never find the ideal site. Equally probable, he would be glad to settle for the location of Great Lakes Steel Corp. at Detroit, Mich., a division of National Steel Corp.

With its greatest drawback, perhaps, the distance from coal deposits, this site is closer to the ore fields than most steel plants; the major portion of its raw materials can be received by water routes (which are also available for some product shipment); power and water supplies are good; and finally, and perhaps most important, it is practically on the door step of the market presented by Detroit's automotive and other industries.

In view of these conditions, it is little wonder that the story of Great Lakes Steel Corp. presents a panorama of continuous construction and expansion unparalleled in the iron and steel industry.

Forerunner of today's plant was a small sheet mill established by the Michigan Steel Corp. July 5, 1923. The success of this venture indicated that there was definite opportunity for an integrated steel plant in this area. The charter for Great Lakes Steel Corp., which succeeded the Michigan Steel Corp., was secured in February, 1929. As construction of the new facilities began, National Steel Corp. was organized by merger of Weirton Steel Co., Weirton, W. Va., Great Lakes Steel and certain other interests, all of which became divisions owned and operated by National Steel Corp.

Just 26 years ago, the site of Great Lakes' modern plant offered a discouraging vista of marsh and flooded lowland—certainly not the most desirable base for the heavy equipment used in a steel plant. However, the area was the only site in the Detroit switching area of adequate size and with the desired water and rail facilities. Furthermore, test hole drilling indicated the presence of rock some 80 ft below present yard level. It was therefore decided that firm foundations could be put in, using piles driven down to the rock bed.

Another problem involved the elevation of the site, which had to be raised about 15 ft, requiring a large amount of fill. Approximately 1,600,000 cu yd of sand were brought by boat from the St. Clair River flats and from Lake Erie. From the boats anchored in the Detroit River, the sand was hydraulically pumped through large pipes to the area to be filled. In addition to the sand, about 2,500,000 cu yd of dry fill was brought in by rail and truck.

The waste marshland was converted into a suitable plant site of 275 acres (now 626 acres), elevated sufficiently to avoid high water troubles, with the Detroit

River to the east, a navigable slip to the north, and the Michigan Central and the Detroit, Toledo and Ironton railroads to the west.

Excavation for the initial construction was started on May 25, 1929. Work progressed at a rapid rate, the first piles being driven June 28, the first concrete poured August 14, and the first steelwork erected October 28.

On August 23, 1930, just 15 months after the start of construction, the first heat of steel was tapped from the open hearth, and two days later the first ingot was rolled on the blooming and billet mills. Strip was first rolled on September 2, 1930, and 14-in. and 10-in. merchant mills were put into operation in March and July, respectively, 1931.

The original project consisted of six 150-ton open hearth furnaces with stockhouse, mold yard and stripper, four blocks of soaking pits of four holes each, a 40-in. blooming mill, a 27-24-21-in. bar and billet mill, a 34-in. strip mill, a 14-in. merchant mill, a 10-in. merchant mill, and the necessary finishing auxiliaries, pump houses, shops, substations, trackage, sewers and water lines.

In 1933 two 150-ton open hearth furnaces and two more blocks of soaking pits were added. In April, 1935, construction began on four more 150-ton open hearth furnaces, additional soaking pits, and the 96-in. hot and cold strip mills. The open hearths were completed in October, 1935, and made a total of 12 furnaces in the shop. The hot mill went into operation on March 23 and the cold mills on June 1, 1936.

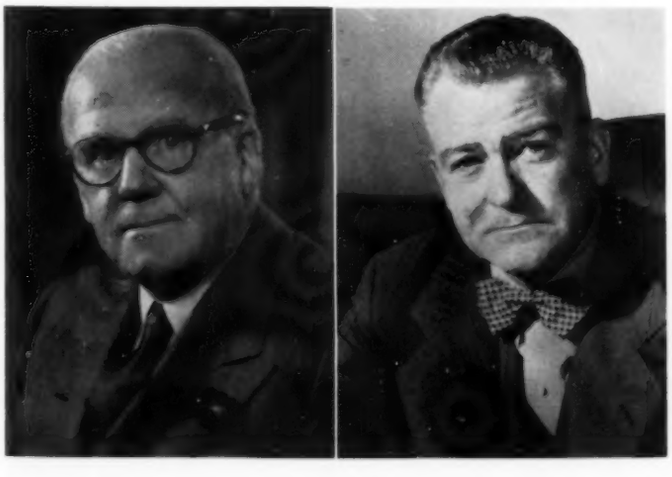
In March, 1937, construction was started on four open hearth furnaces in a new shop, which were completed in February, 1938. A 46-in. slabbing-blooming mill was started in July, 1937, and put into operation on May 23, 1938.

In a move to increase production, two bessemer converters were installed in 1946 to furnish blown charge metal to No. 1 open hearth shop. A similar unit was put in for No. 2 open hearth in 1953. Enlargement of open hearth furnaces to 500-ton heats began in 1949. Cold finishing facilities for wide strip were expanded in 1948,

NATIONAL STEEL CORPORATION

E. T. WEIR
Chairman

THOMAS MILLSOP
President



PAUL CARNAHAN
President

A. E. KADELL
Senior Vice-President

D. E. McGUIRE
Vice-President, Engineer

GREAT LAKES STEEL CORPORATION

and a new universal slabbing mill was started up in 1953.

In 1934, Great Lakes acquired the Stran-Steel patents for a nailable steel construction member. Part of the old Michigan Steel plant as well as an entire plant in Terre Haute, Ind., are devoted to the fabrication of a light structural material which features a nailing groove in the steel members and Quonset and other buildings in which these members are used.

Meanwhile, on Zug Island, some 2½ miles from the steel plant, a parallel expansion program went on at the same rapid pace. Here, two small blast furnaces, built in the early 1900's were operated by the Hanna Furnace Corp., producing merchant iron. Great Lakes assumed operation of these furnaces late in 1931, using the molten iron in its open hearth furnaces. In March, 1937, construction was started on a 1000-ton blast furnace, a 130-oven coke plant and attendant auxiliaries. This furnace was put into blast August 16, 1938, and the coke plant started October 6 of the same year. In 1941, a sintering plant was put into operation and an old blast furnace was dismantled to make room for a new large furnace, which was lit on December 9, 1941.

On September 22, 1952, a third large furnace was put into operation, and a fourth (at present the largest in the world) is just about completed on the site of a small furnace. A new coke plant was started January 1, 1955.

The site of the blast furnace division presented foundation problems similar to those at the steel plant, and similar methods were used to provide firm foundations.

The rapid expansion at both the steel plant and the blast furnace plant naturally required a great amount of construction on auxiliary facilities. At various times, extensions were made to pickling, annealing and finishing departments. In 1941 and 1942, facilities were installed for finishing plate and shell steel.

The foregoing schedule indicates the rapidity with which this plant grew to its present capacity.

RAW MATERIALS

Iron ore comes partly from the recently opened Labrador field, but principally from mines in the Mesabi and Old Range fields, owned by subsidiary or affiliated companies of National Steel Corp. Analyses average as follows:

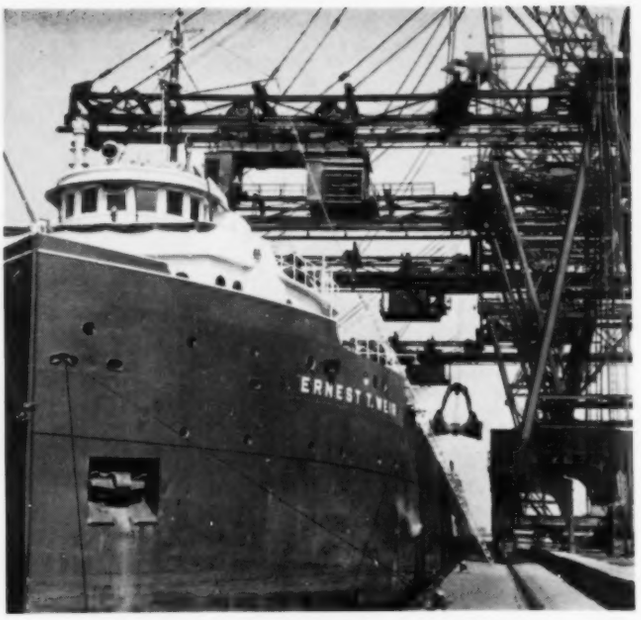
	Portsmouth	Hanna	Weir
Iron	47.71	54.80	55.80
Phosphorus	0.265	0.076	0.444
Manganese	3.39	0.54	0.20
Silica	15.26	11.78	7.43
Alumina	3.38	1.76	3.60
Calcium oxide	0.58	0.32	0.36
Magnesium oxide	0.15	0.41	0.46
Moisture	11.54	10.0	10.20

The Portsmouth and Weir ores are received as mined. Hanna ore is a mixture of various ores put together at the mines.

All ore is received by water, the carriers being unloaded by ore bridges at one of two locations. One, on the Rouge River, is provided with three nine-ton bridges and two five-ton bridges, and has storage capacity of 400,000 gross tons of ore. Another yard, with storage capacity for 550,000 gross tons, has two 10-ton bridges. Ore comes to this yard by transfer car from the Rouge River unloading dock. A third storage yard, with three 15-ton bridges and capacity for 450,000 gross tons, runs along the Detroit River, and receives ore directly from the boats as they are unloaded.

Ore is reclaimed from storage by the bridges and moved by six transfer cars (four of 50-ton capacity, two of 60-ton) to the stock bins of the blast furnaces. The high line serving furnaces A, B and C runs along No. 1 storage yard and loops around to run along No. 2 yard.

Effective in 1955, limestone will be supplied from a quarry at Presque Isle, owned by an affiliated company, the Presque Isle Corp. Prior to this, stone was shipped by rail from Kelly Island Lime and Transport quarry at Marblehead, Ohio. Stone analyses are about as follows:



Ore carriers are unloaded by bridges at either of two docks at the Zug Island plant.

	Per cent
Silica	.54
Alumina	.24
Calcium oxide	50.69
Magnesium oxide	6.1
Phosphorus	.008
Sulphur	Trace

The stone is crushed and screened at the quarry to a size of 3 in. x 6 in. Shipments will come to the furnace plant by water, going both to storage and directly to the furnaces. There is a storage area of 450,000-ton capacity to which stone is moved by a 4500-ton per hr conveyor system. Diesel shovels (2½ cu yd) reclaim

The M. A. Hanna Co. Portsmouth mine, an open pit in the Cuyuna range, supplies part of the iron ore used at Great Lakes.

stone from storage and load it into hopper cars which take it to the furnace stock bins.

Coal comes from various mines in W. Va., Pa., Va. and Ky. Analyses average about as follows:

	Pocahontas	Freeport	Clintwood	Elkhorn
Volatile matter	16.71	36.37	32.99	37.88
Fixed carbon	77.15	54.08	61.36	58.84
Ash	6.14	6.55	5.65	3.28
Sulphur	0.62	1.29	0.74	0.85
Moisture	4.28	3.97	3.99	4.88

Freeport and Elkhorn coals are washed at the mines. The Pocahontas and Clintwood coals are partially washed. No washing is done at the Great Lakes plant.

Coal is delivered in self-unloader boats which may be unloaded at either of two locations, both on the Detroit River. The original installation includes a 7000-ton receiving bin to avoid delaying the boats. Coal is discharged into this bin at a rate of 1500 tons per hr and is taken out through a series of gates, over a traveling shaker feeder and on to a 42-in. conveyor system which moves the coal to No. 1 coal storage at a rate of 600 tons per hr, or to the coal preparation system of No. 1 coke plant. Two traveling stackers serve No. 1 yard, which has a capacity of 400,000 tons.

The second coal storage area, with 350,000 tons capacity, is likewise served by a conveyor and stacker. This equipment handles coal at a rate of 2500 tons per hour, making a receiving bin unnecessary. This same stacking equipment also serves the limestone storage, which is adjacent to No. 2 coal storage.

At the storage yards, coal is piled by the self-propelled stackers which can travel the entire length of the yards (about 1500 ft). The coal is spread and rolled in three-ft layers by bulldozers to a total height of 40 ft.

At the quarries, power shovels load limestone into trucks which carry it to a plant where it is crushed and screened.

Track hoppers to take care of rail shipments are installed adjacent to No. 1 storage field and at the coal preparation systems of both coke plants. Rail shipments of coal are held to a minimum.

Coal is reclaimed from the storage fields by tractor cranes and bulldozers. At No. 1 yard, it is loaded into self-propelled hoppers which discharge on to 42-in. belt conveyors leading to the preparation systems of both coke plants. At No. 2 field, the cranes load coal into hopper cars which are then unloaded at the track hoppers at either plant.

About 5900 tons of coal are used per day with normal coke plant operations.

This newly completed battery of 70 by-product ovens will coke 1800 tons of coal per day.

COKE PLANT

Coking facilities include three batteries of by-product coke ovens, two of 73 ovens each, one of 70 ovens, the latter recently completed and located about one-third of a mile from the other batteries.

At each coke plant, coal is put through two 12 ft x 17 ft breakers which crush it to $-1\frac{1}{2}$ in. The coal is then conveyed to six mixing bins. Feeder belts from each bin bring the desired amounts of the various coals together and the blend passes through two hammer mills rated at 250 tons per hr each. The fine coal (70 per cent through a $\frac{1}{8}$-in. screen) is conveyed to a 3000-ton oven storage bin, divided into five compartments at No. 1 plant and a three-compartment 2100-ton bin at No. 2 plant.

The usual mixture consists of 22 per cent Pocahontas, 20 per cent Freeport, 35 per cent Clintwood and 23 per cent Elkhorn, and analyzes about as follows:

	Per cent
Volatile matter	30
Fixed carbon	64
Ash	5.25
Sulphur	.85
Moisture	4.40

The two older batteries have ovens 42 ft $9\frac{1}{2}$ in. long between door faces, 13 ft $5\frac{5}{8}$ in. high and $15\frac{1}{2}$-$18\frac{1}{2}$ in. wide. They are charged with coal to a height of 12 ft 5 in., taking a coal charge of 18.07 tons.

The ovens are arranged for underfiring by either coke oven gas, blast furnace gas or both. Normally, blast furnace gas is used with about five-per cent by volume of coke oven gas. The heating wall contains 28 vertical flues divided into four zones of seven flues each, with a horizontal flue connecting each pair of zones. Four regenerators are located under each oven, each connected to one of the four heating zones in the oven wall.

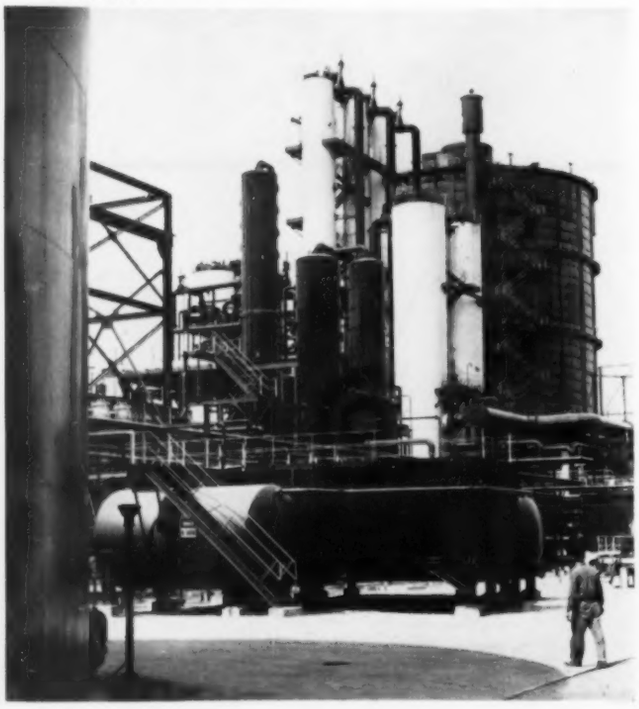
The two batteries are served by three combination pusher-leveler-door machines on the pusher side, and three door machines on the coke side. There are also three gantry type three-hopper charging cars. Coke pushed from the ovens is handled by quench cars and electric locomotives to either of two transite-lined steel quench towers. Water for the quenching sprays is recirculated.

From the wharf, coke is conveyed over a double-decked shaker screen which separates the furnace and nut sizes. A single-decked scalping screen and a crusher is available to reduce oversize coke when necessary. The pea and breeze mixture is separated on a single-decked screen, pea coke being loaded into hopper cars for sale and breeze being delivered by conveyor to the boiler house. Another screen with electrically heated screen cloth is also available to separate out fine breeze ($-\frac{1}{4}$ in.) for sinter plant use.

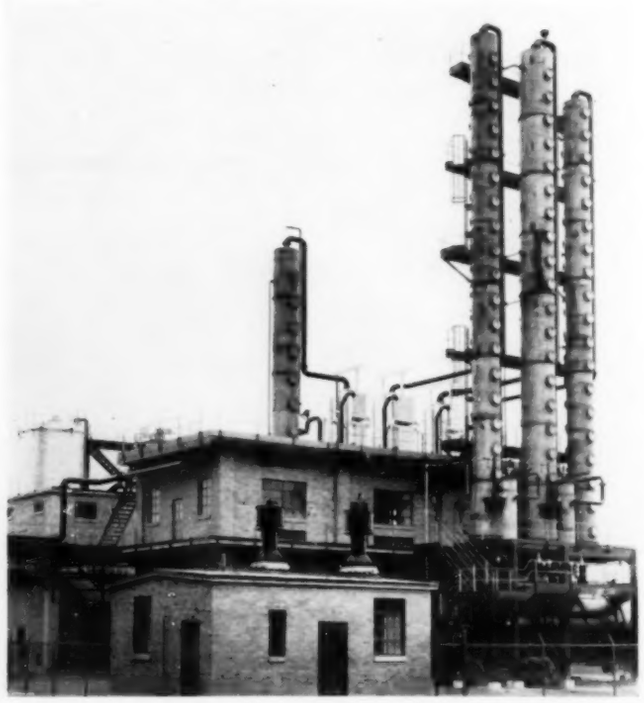
By-product equipment at No. 1 plant consists of parallel primary and secondary gas cooling, scrubbing and purifying apparatus served by three centrifugal exhausters each driven by a 400 psi steam turbine.

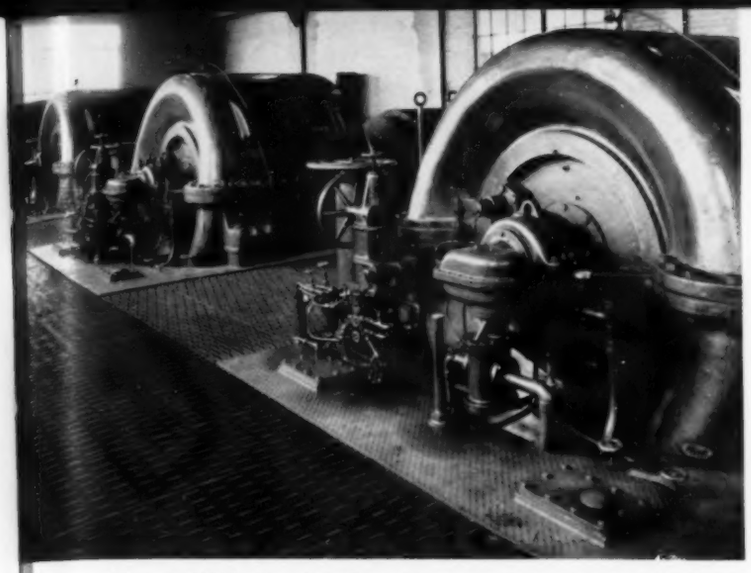
Ammonia is removed by three wooden grid scrubbers in series. Ammonia is shipped as weak liquor. No sulphate is made in this plant. A low pressure sulphur eliminator column removes about 60 per cent of the hydrogen sulphide from the gas, returning the sulphur to the blast furnace fuel gas main. The gas then passes through light oil scrubbers. Light oil is stripped and refined in a fractionation column with correction column which delivers the light oil to the benzol plant and the carbolic oil fraction, including the naphthalene, to a storage tank for eventual shipment.

The primary coolers and light oil recovery equipment shown here handles the gas from the new battery, but is designed to serve an additional battery should one be added.



The new benzol refining plant is designed to handle these products from the three existing batteries, as well as a future fourth battery.





Four 27,000 cfm, 6 psi pressure boosters move mixed gas of 385 Btu per cu ft to the steel plant, where it is used in soaking pits, heating and annealing furnaces, and open hearths.

The benzol plant has two 5000 gal light oil washers, one direct steam stripping column, a sulphur removal column, a pure benzol column, and a pure toluol and solvent column which delivers toluol in the vapor phase, xylol as a side stream take-off, and heavy solvents as a bottom take-off from the reboiler. The last four columns operate as a continuous system.

The third battery, newly completed, has 70 underjet four-divided, low differential ovens 40 ft 7⅝ in. long, face to face of the doors, 13 ft 2⅜ in. high and 16⅝-20⅛ in. wide, each capable of taking a coal charge of 17.15 tons. As in the case of the other batteries, these are arranged for firing with coke oven gas, blast furnace gas or both.

The new battery is served by two rotating table type, three-hopper charging cars, two hydraulically operated door machines on the coke side, and two combination pusher-leveler-door machines, also hydraulically operated. The leveler on these units is equipped with a conveyor for returning coal spillage into the oven. One brick-lined concrete quenching tower is provided and the coke is handled by two quench cars operated by electric locomotives.

Coke from this battery is handled essentially in the same manner as at the other batteries, except that a scalping grizzly is substituted for the single-decked scalping screen ahead of the crusher. Also, no screen is installed for the separation of fine breeze.

A new by-product plant has been constructed, designed to handle the gas from the new battery but with provisions to accommodate the gas from another battery at some future date. This plant consists of two wooden grid primary coolers, two turbine-driven exhausters, two ammonia absorbers, two final coolers, two spray-type light oil scrubbers and one spray-type sulphur scrubber.

Phenol is removed from the weak ammonia liquor by absorption in light oil and springing with caustic soda, producing phenol carbolate.

Three ammonia stills are provided to free ammonia in the weak liquor, with ammonia vapor entering the gas stream ahead of the absorbers.

Two continuous centrifugal dryers, sulphate storage, a loading crane and auxiliaries are provided to handle ammonia sulphate produced in the absorbers. Ammonia liquor from No. 1 plant is transferred to No. 2 plant for the production of sulphate.

The new benzol plant consists essentially of two 10,000-gal light oil washers and a four-column still similar to that in No. 1 plant except that the fourth column, which produces toluol, xylol and heavy solvents, operates on the conventional batch method.

The phenol removal, ammonia sulphate and benzol departments of the new plant are designed to handle these products from both plants, or an eventual four-battery operation.

A total of 230 ovens are pushed daily from the two original batteries, giving coking capacity for 4100 net tons of coal per day. The new battery is rated at 105 ovens daily, or a capacity of 1800 net tons of coal per day. The three batteries provide a combined capacity for 1,600,000 net tons of coke per year.

Yields average about as follows:

Furnace coke, per cent	71.3
Nut coke, per cent	5.1
Pea coke, per cent	1.8
Breeze, per cent	4.8
Gas, cu ft per ton of coal	10,000
Tar, gal per ton of coal	8.2
Light oil, gal per ton of coal	3.3
Ammonia sulphate, lb per ton of coal	20.

Surplus coke oven gas is mixed with blast furnace gas to form a 385-Btu per cu ft gas which is sent the steel plant for use in open hearths, soaking pits and heating furnaces. The coke oven gas is purified at No. 1 coke plant by scrubbing with liquor and at No. 2 plant by the hot actification soda ash process. Surplus coke oven gas from the by-product departments of both coke plants flows directly to boosters through a pressure controlled butterfly valve. Blast furnace gas flows from the two 1,500,000 cu ft waterless holders, under holder pressure, and unites with the coke oven gas at the inlet of the boosters in the desired proportions. The mixed gas, of 385 Btu per cu ft and totaling 75,000,000 cu ft per day, is pumped at pressures of 3-5½ psi through a 42-in. main to the distribution system at the steel mill. To make up shortages for peak loads there is a mixing station at the steel plant where natural gas and air are mixed to a calorific value approximating that of the mixed gas.

Occasionally, some coke oven gas is purchased from a neighboring coke plant.

At the steel plant, the mixed gas is carried in a loop system to the various consuming departments, which include open hearths, soaking pits, heating furnaces and annealing furnaces.

Furnace coke from No. 1 plant is loaded into hopper cars for delivery to the blast furnace stock bins. A belt conveyor moves coke from No. 2 plant to the furnace bins of D furnace. Coke analyses average as follows:

	Per cent
Volatile matter	.9
Fixed carbon	91.6
Ash	7.5
Sulphur	.62
Moisture	2.0

BLAST FURNACES

Iron making facilities include four modern blast furnaces, one of which, just nearing completion, is at present the largest furnace in the world. Table I gives principal dimensions, as well as some operating figures for the three existing furnaces.

All of the furnaces have conventional cooling staves around the hearth, with copper cooling plates extending up through the bosh for eight or nine rows above the mantle. Stocklines are protected by cast steel wearing plates set in concrete. Furnaces C and A have crucible walls of carbon brick laid directly against the jacket.

Each furnace has a conventional double skip, with the skip cars dumping into a rotating distributor top. Bells are operated by electric hoists on furnaces B and C, and by pneumatic hoists on furnaces A and D. All furnaces are equipped with automatic charging sequence control, but charging sequences vary for various furnaces. Ore, stone and coke are all charged by weight.

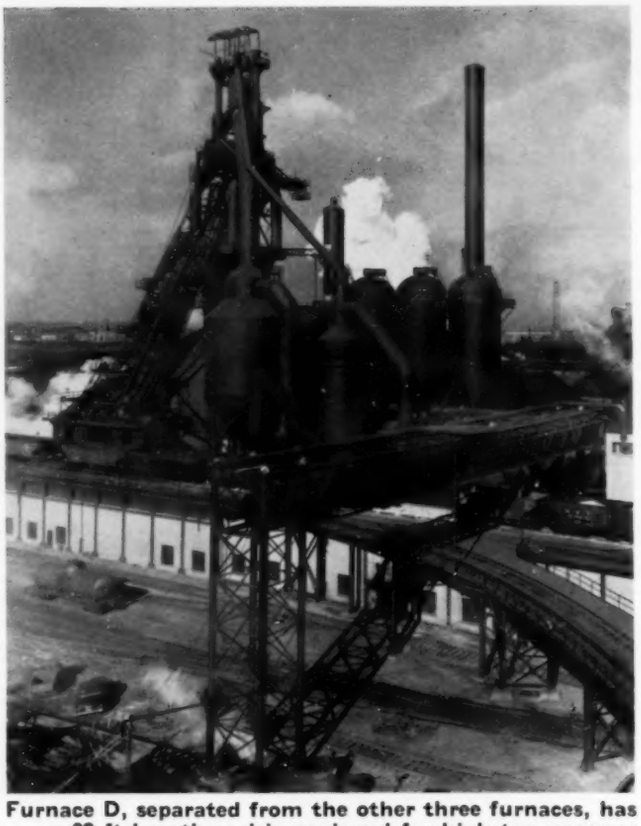
Blast for furnaces, A, B and C comes from four turbo blowers in No. 1 blower house. These units vary in size, with characteristics as follows:

One, 125,000 cfm, 35 psi, driven by a 15,750 hp, 420 psi turbine, with 9500 sq ft surface condenser, normally intended for A furnace.

One 60,000 cfm, 30 psi, driven by a 7000 hp, 420 psi turbine, with 4300 sq ft surface condenser, normally a spare.

One 75,000 cfm, 30 psi, driven by an 8500 hp, 420 psi turbine with 5250 sq ft surface condenser, normally used on C furnace.

One 85,000 cfm, 30 psi driven by a 9570 hp, 420 psi turbine with 5500 sq ft surface condenser, normally on B furnace.



Furnace D, separated from the other three furnaces, has a 28 ft hearth and is equipped for high top pressure operation.

D furnace is served by one 125,000 cfm, 35 psi blower driven by a 15,750 hp, 420 psi turbine, with an 11,000 sq ft surface condenser. This unit is located in No. 2 blower house.

Furnaces D and A are equipped for high top pressure operation.

Blast is preheated in the stoves listed in Table I. All of the stoves are of two-pass, side combustion design, with small checker flues. Blast temperatures, which are automatically controlled by mixer valves, average about 1000 F, with maximum peaks up to 1450 F. The stoves are fired with clean blast furnace gas through proportioning pressure burners. Stove cycles are normally four hours on gas, two hours on blast. Waste gases at the stove stacks average about 250 F.

Gas leaves the top of each furnace through four off-takes, 5 ft 6 in. in diameter on furnaces B and C, 5 ft 9 in. on A and D. The four off-takes on each furnace are combined into two up-takes, which in turn combine into a single downcomer.

All blast furnace gas is cleaned to a high degree. Each furnace is equipped with a dust catcher, a wet washer and an electrical precipitator. Dust in the gas averages .12-.14 grains per cu ft leaving the wet washers, and .003-.005 grains per cu ft leaving the precipitators. About 23 per cent of the gas is used in the blast furnace stoves. Surplus gas is used for boiler fuel and underfiring coke ovens, and in a mixed gas system for open hearth fuel. Some surplus gas is also sold to a near-by central power station for boiler fuel.

Effluent from the gas washers of all four furnaces flows to two 80 ft diameter double compartment thickeners which can handle up to 12,000 gpm. Sludge from

Three of the Zug Island furnaces are aligned along the Rouge River dock. Furnace A at the right is being completely rebuilt with a 30 ft 3 in. hearth diameter.

the thickeners is put through two drum filters 11 ft 6 in. in diameter x 14 ft long.

Material from the filters and dust from the dust catchers and precipitators is sintered in a 72 in. x 120 ft moving grate machine with 16 wind boxes. The machine has a capacity of 1500 tons of sinter per day and is equipped with a double inlet fan rated at 170,000 cfm, 300 F, 26 in. vacuum.

The furnaces produce basic iron for the open hearths, in analyses averaging as follows:

	Per cent
Silicon	.90-1.10
Sulphur	.025
Phosphorus	.26
Manganese	1.0

Each furnace is tapped five times in 24 hours into 110-ton mixer type ladles which are moved to the open hearth departments at the steel plant 2½ miles way.

In emergencies, iron may be put over either of two pig machines, one of which is double strand, the other single.

Slag flows into an open pit at each furnace and is subsequently loaded into trucks and hauled out by a commercial processor. A typical slag analyses shows:

This single turbo blower, rated at 125,000 cfm, 35 psi, serves D furnace.

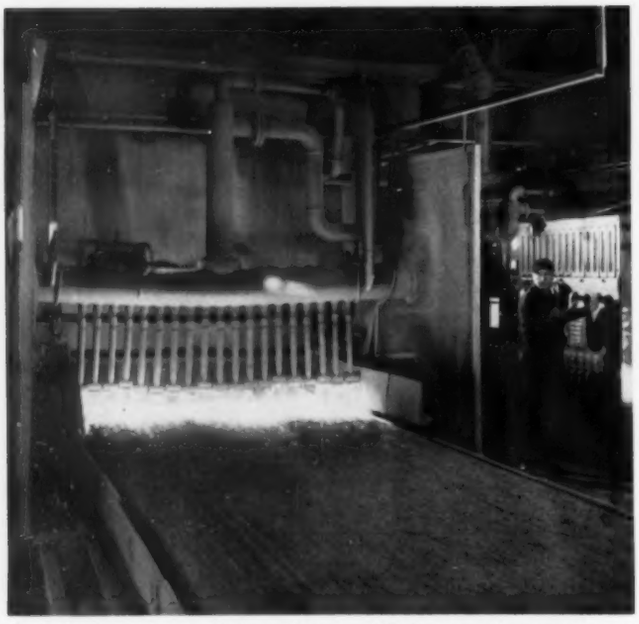
	Per cent
Silica	36.88
Alumina	10.40
Calcium oxide	43.31
Magnesium oxide	6.20
Sulphur	1.35
Iron	.30
Manganese	.48

TABLE I

Blast Furnace Data*

Furnace No.	B	C	D
Diameter of hearth, ft-in.	27-3	27-3	28-0
Diameter of bosh, ft-in.	30-3	30-3	31-3
Diameter of stockline, ft-in.	20-0	20-0	23-0
Height, iron notch to top ring, ft-in.	104-4	100-0	106-9
Height of crucible, ft-in.	6-0	6-0	6-2
Height of bosh, ft-in.	10-0	10-0	11-0
Height of straight section, ft-in.	6-0	6-0	10-0
Height of inwall section, ft-in.	58-6	54-3¾	55-9
Height, stockline section to top ring, ft-in.	10-3	10-3	10-2
Height, bottom to iron notch, ft-in.	2-0	2-0	2-0
Height, iron notch to cinder notch, ft-in.	4-8	4-8	4-8
Height, cinder notch to tuyeres, ft-in.	3-4	3-4	3-6
Working volume, tuyeres to stockline, cu ft	42,577	39,642	47,955
Bosh angle, deg-min-sec	81-28-09	81-28-09	81-35-40
Inwall slope, in. per ft	1.051	1.132	0.995
No. of tuyeres	16	16	20
No. of columns	8	8	10
Lining thickness, crucible, in.	36	36	36
Lining thickness, bosh, in.	27	27	27
Lining thickness, stack, in.	45	49	40½
Lining thickness, throat, in.	44	44	45
Big bell diameter, ft-in.	15-0	15-0	16-6
No. of stoves	3	3	3
Stove diameter, ft-in.	24-0	24-0	26-0
Stove height, ft-in.	100-0	100-0	115-0
Checker openings, in.	1 15/16	1 15/16	2 and 2 5/8
Heating surface per stove, sq ft	191,000	191,000	237,500
No. of turbo blowers	1	1	1
Blower capacity, cfm	85,000	75,000	125,000
Blower pressure, psi	30	30	40
Steam to blow, lb per hr, average	75,000	70,000	80,000
Blast volume, cfm, average	78,000	77,000	99,000
Blast volume, cfm, maximum	82,000	77,000	105,000
Normal blast pressure at tuyeres, psi	21	20	24
Normal top pressure, psi	2.6	2.6	7.5
Lb of ore per gross ton of iron	2803	2873	2943
Lb of stone per gross ton of iron	891	911	839
Lb of coke (4.7 per cent moisture) per gross ton of iron	1429	1557	1560
Lb of scrap charged per ton of iron	602	612	503
Lb of roll scale per ton of iron	5% of ore burden	None	6.67% of ore burden
Daily iron production, net tons, average	1462	1400	1624
Daily iron production, net tons, maximum	1684	1618	2009
Lb of slag made per ton of iron	970	969	910
Lb of flue dust made per ton of iron	210	160	250

*Furnace A is at present being rebuilt.



A sintering plant, with a 72-in. x 120-ft traveling grate and 16 wind boxes, turns out about 1500 tons of sinter per day.

The entire coke plant and blast furnace layout, covering 121 acres, is compact but nevertheless provides for free flow of materials and products. Essentially, the layout sets up two separate plants. Furnaces A, B and C form a line (essentially east and west) which is parallel by ore storage. No. 1 lying along the Rouge River along the north side of the property. The two oven batteries of No. 1 coke plant form a line paralleling the furnace line, with the by-product and benzol plant at the east end of the battery line.

Beyond the screening tracks and coal tracks on the south side of the batteries are No. 2 ore storage yard and No. 1 coal storage area. The end of this coal storage butts against the coal dock on the Detroit River, along the east side of the property.

D furnace lies on another line parallel to the line of furnaces A, B and C, but some 1500 ft away. No. 3 ore yard lies along the Detroit River at about 90 degrees to the line of D furnace.

The new No. 2 coke plant parallels the line of D furnace. The by-product and benzol plant of this installation is much roomier than that at No. 1 coke plant, since it is designed to take care of an eventual four-battery operation.

Along the south line of the property, the new 350,000-ton coal storage yard and the limestone storage area parallel the east-west axes of the plant.

When the demand for iron necessitated a fourth blast furnace, the possibility of putting it at the steel plant was thoroughly investigated, but the survey showed that more economical operation was to be had with the Zug Island location. The layout of D furnace and No. 2 coke plant will permit the construction of another battery of coke ovens when further expansion is needed.

OPEN HEARTH

Steelmaking facilities include two open hearth shops, each with a converter plant for pre-blowing hot iron down to a suitable charge metal.

No. 1 shop contains 12 basic furnaces of four different sizes, built on 110-ft centers. Three are rated at 250 tons and have hearths 48 ft x 14 ft; one is rated at 300 tons and has a 57 ft x 16 ft hearth; one is a 425-ton unit with 55 ft x 16 ft hearth; and seven are 500-ton furnaces, with 57 ft x 16 ft hearths. The furnaces are 86 ft 3 in. overall length and 21 ft 3 in. to 23 ft 3 in. overall width, inside the binding. The hearths vary from three ft to 3 ft 11 in. in thicknesses and are composed of 9-18 in. of firebrick, 15 in. of chrome brick and 11-14 in. of rammed magnesite. Both depth ranges from 37 in. to 51 in., depending on furnace size.

Basic brick is used only in front wall construction.

All of the furnaces have sloping back wall construction.

Furnace roofs are of sprung arch construction, of silica brick 15 in. x 6 in. x 3 in., with 18 in. ribs every fifth course. Height from foreplate to bottom of skewbacks is 4 ft 10½ in. in front and 4 ft 1 in. to 4 ft 10½ in. in back.

Downtake area ranges from 66.6 sq ft to 76.6 sq ft at each end of the furnace, depending on furnace size.

A single slag pocket is used on each end, ranging 19-20 ft long, 15 ft wide, and 9-10 ft high.

Double regenerators are used on each end of the furnace, divided unequally. The small chamber is 9 ft 9 in. wide, the larger, 16 ft wide. Both are 28 ft 4 in. long and 25 ft high, giving volumes of 6905 and 11,332 cu ft, respectively, for the small and large chambers.

Checkerwork is of basket design, built of 12 in. x 6 in. x 4 in. brick, giving 8 in. x 8 in. vertical flues and 6 in. x 8 in. horizontal openings. Checkerwork is 10-12 ft high, giving checkerwork volume of 7300-8800 cut ft on each end of the furnace.

No. 2 shop contains five furnaces, three rated at 250

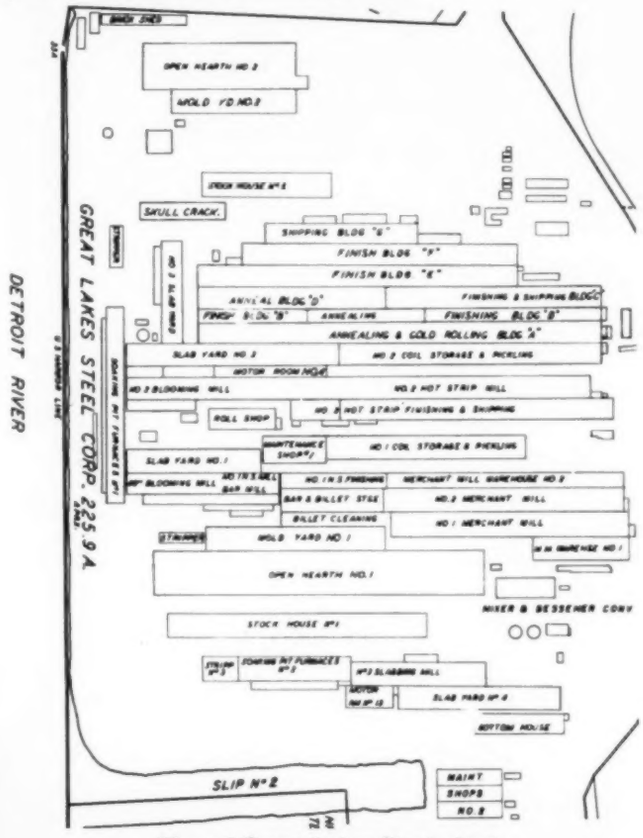
Open hearth furnaces, varying from 250 tons to 500 tons in capacity, produce basic steel from conventional scrap-hot metal charges or from charges of 65 per cent blown metal, 35 per cent scrap.

tons, with 48 ft x 14 ft hearths; one at 500 tons, with 57 ft 6 in. x 16 ft hearth; and one at 500 tons with a 57 ft x 16 ft hearth. All hearths are 3 ft 6 in. thick, built up of 11-12 in. of firebrick, 18 in. of chrome brick and 12-14½ in. of rammed magnesite.

Furnace construction and dimensions are essentially the same as in No. 1 shop.

No. 1 shop contains five 7½-ton charging machines, and two similar units are installed in No. 2 shop. Charging boxes in both shops are 25 cu ft volume.

Oil is the principal fuel, with only about 6.5 per cent of total fuel input being mixed gas of 385 Btu per cu ft, principally off-peak consumption.



Map of Great Lakes Steel plant.

Oil is delivered from boats docked in a slip at the north end of the property, through an eight-in line to oil storage tanks north of the plant site and then to two 631,000-gal and one 20,000-gal storage tanks near No. 1 open hearth shop. At the main pumping station, the oil is strained, heated, and moved by four pumps (67 gpm each) out into a recirculating loop system. Each open hearth furnace has an individual pump and heater with automatic temperature control. Oil comes to the burners at about 225 F, 200 psi. Steam runs about 135 psi pressure, 350 F temperature.

From the main pumping station, oil is also pumped to a 200,000 gal storage tank at No. 2 open hearth shop.

Gas comes from the mixing station located at the blast furnace plant.

No automatic controls are installed on the furnaces. Fuel oil and gas are metered, and steam flow meters are being installed. Forced draft is applied only to one furnace in No. 1 shop and four furnaces in No. 2 shop.

Each furnace is equipped with a 6000 sq ft waste heat boiler, each producing 150 psi steam at a rate of about 18,000 lb per hr.

Steel in a wide range of low carbon rimming, forging and alloy grades, is poured into big-end-down molds ranging from 26 in. x 26 in. to 23 in. x 82 in.

Water-cooled sliding dampers are used, providing 20 sq ft and 28.4 sq ft area for the small and large regenerators, respectively. Furnace stacks are 159 ft 3 in. high and eight ft in diameter inside the lining.

The large furnaces on scrap-hot metal charges run 3,700,000-4,400,000 Btu per ton of ingots produced, whereas furnaces on blown metal consume 2,500,000-3,000,000 Btu per ton. The small furnaces with scrap and hot metal average about 16 hr heat time, tap to tap, and the large furnaces, with blown metal, 14-16 hr, tap to tap. Maximum fuel input is 75,000,000 Btu per hr.

Some oxygen, introduced by lancing through the door, is used for decarburization of the bath. Oxygen comes from a liquid oxygen storage.

Flux consumption averages 165 lb (including 13 lb of feed ore) per ton of steel, and ferroalloys about 15 lb per ton.

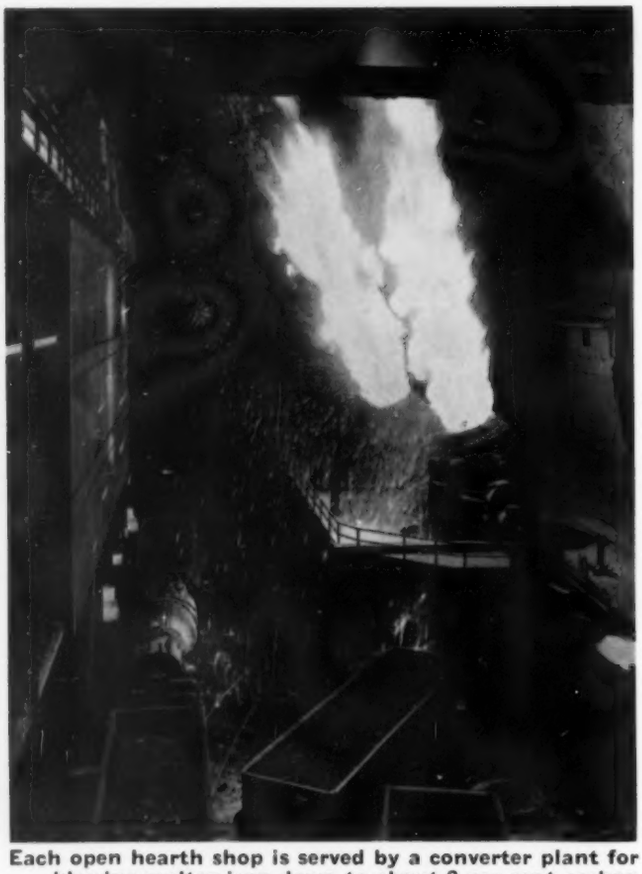
Slag, which runs 9-10 per cent, is hauled to a dump.

Deoxidation is carried on in the furnace and ladle, with a limited amount of mold deoxidation.

Steel is made in a wide range of low carbon rimming, forging and alloy grades. The furnaces are tapped into 250-300 ton ladles and poured into big-end-down molds ranging from 26 in. x 26 in. to 23 in. x 82 in. Molds are sprayed with graphite before teeming.

Each of the two converter plants, which are essentially duplicates, contains a 1300-ton barrel type mixer and two 25-ton vessels of 10 ft 1 in. inside diameter and 23 ft 9⅞ in. overall height. Two 45,000 cfm, 30 psi, motor-driven turbo blowers, equipped with hydraulic control, are installed in each shop. They are arranged to blow the converters individually or into a common system.

The converters are lined with silica firestone, white stone and white plastic clay. The bottoms are made up of a mixture of stone and fireclay, rammed in with air hammers. Each bottom contains 31 tuyeres, each



Each open hearth shop is served by a converter plant for blowing molten iron down to about 2 per cent carbon for open hearth charges.

with seven $\frac{5}{8}$ in. holes. Bottom life averages 56 blows. Wet grinding pans, lining pits and drying ovens are provided in each location for bottom maintenance.

Iron coming from the blast furnaces in 110-ton mixer type ladles is reladled into 75-ton ladles which are emptied into a 1300-ton barrel type mixer or taken direct to the open hearth for the conventional scrap and iron process. Self-propelled, self-tilting ladle cars transfer iron from the mixer to the converters.

The iron is partially blown to produce a suitable charge metal for open hearths. The change in the metal is approximately as follows:

	Iron	Blown metal
Carbon	4.10-4.25	2.00-2.25
Manganese	0.80-1.00	0.08-0.14
Phosphorus	0.24-0.26	0.24-0.26
Sulphur	0.020-0.035	0.020-0.035
Silicon	1.10-1.35	0-0.01

The blow averages 7.16 minutes, air on to air off. Scrap is added to the bath to the amount of 10-12 per cent, and oxygen is introduced into the blast during 12 per cent of the actual blowing period. Each vessel can produce 110-120 tons per hour. Each converter plant can supply about 100,000 tons per month to its respective open hearth shop. At present, the converters at No. 1 plant are being enlarged to handle 40-ton blows.

Iron is poured out of the converters into transfer ladle cars which are moved into the open hearth by car haul. In the open hearth, these ladles are moved by transfer car and crane, just as in the case of molten iron.

Insofar as possible, the large furnaces are given priority on the blown metal, since charging and melt-down time would otherwise run abnormally long. In such heats, about 65 per cent blown metal is used with 35 per cent scrap. When blown metal is not available, a conventional charge of about 45 per cent iron, 55 per cent scrap is used.

BLOOMING AND BILLET MILLS

The Great Lakes plant has three blooming mills, the original 40-in. unit completed in 1930, the 46-in. mill installed in 1938, and the 45-in. universal slabber put into operation in 1953. Some details of these three mills and their drives are set forth in Table II.

No. 1 and 2 mills are served from soaking pits common to both. There are 15 rows of pits of four holes each. Eleven rows are of regenerative, reversing design, each hole being 16 ft long x 6 ft wide x 9 ft deep, and capable of holding six large ingots. In the other four rows, which are one-way fired recuperative units, the holes are 20 ft 8 in. long x 7 ft wide and vary in depth from 11 ft 2 in. to 11 ft 9 in. Each of these holes will accommodate ten large ingots.

All of these pits are located in line in a building extending across the ends of the mill buildings. Ingots from the open hearth shops (one on each side of the mill buildings) may be delivered through either end of the pit building.

All of the pits are fired with mixed gas of 385 Btu per cu ft. Fuel consumption averages about 1,200,000 Btu per net ton of ingots heated. All of the pits are equipped with automatic controls on fuel-air ratio, furnace pressure and temperature.

Four pit cranes and two ingot buggies charge and draw the ingots, and move them to the mill tables.

The 40-in. blooming mill, a unit of the original construction program, generally rolls blooms for the billet mill and slabs for the 38 in. strip mill.

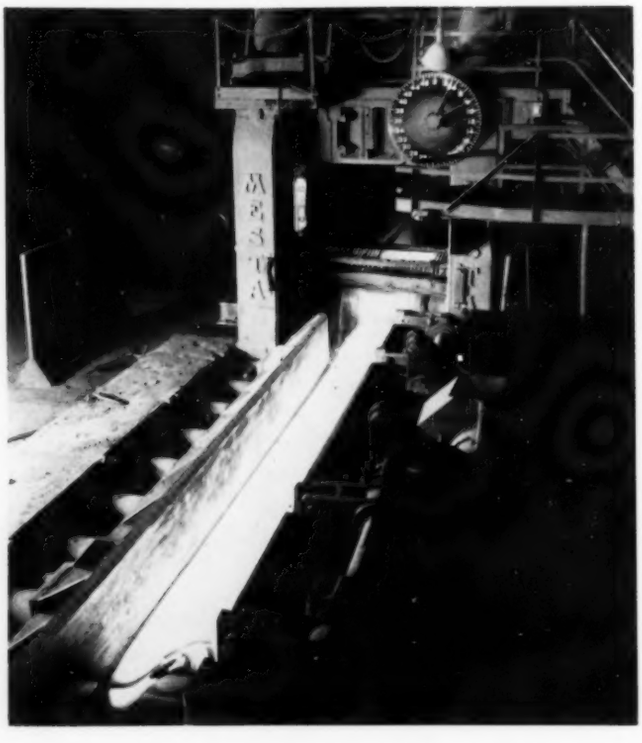


TABLE II

Blooming Mill Data

	No. 1	No. 2	No. 3	
Size, in.	40	46	45	
Type	2-high, reversing	2-high, reversing	2-high, reversing, universal	
			Horizontal	Vertical
Roll diameter, in.	38	43	45	37
Roll body length, in.	92	100	90	96
Roll neck bearings	Composition	Composition	Composition & babbitted	Roller
Mill spindle diameter, in.	18	21	24	16
Mill screw diameter, in.	12	16	16	12
Mill screw pitch, in.	2	2	2½	2
Roll movement speed, fpm	12.5	30	50	16.5
Screwdown motors, no. & hp	One, 150	Two, 150	Two, 200	Two, 150
Roll balance	Counterweight	Counterweight	Counterweight	Hydraulic
Main drive motor—Hp	7000	7000	Two, 6000	4000
—Rpm	50-120	40-100	40-70	60-150
—Voltage	700, d-c	700, d-c	700, d-c	700, d-c
MG set—No. of generators	2	3	4	2
Kw, each generator	3000	2500	2500	1750
Generator voltage	700, d-c	700, d-c	700, d-c	700, d-c
Drive motor, hp	5000	6000	9000	
Drive motor, rpm	352	352	514	
Drive motor, voltage	6600	6600	6600	
Drive motor type	W. R. induction	W. R. induction	W. R. induction	
Flywheel type	Steel plate	Steel plate	Steel plate	
Flywheel diameter, ft-in.	15-0	15-0	14-0	
Flywheel weight, lb	140,000	140,000	128,000	
Maximum drive torque, ft-lb	2,200,000	2,520,000	3,540,000	
Maximum roll face speed, fpm	1140	1125	825	
Pinion pitch diameter, in.	40	46	None	
Pinion face, in.	56	65	—	
Pinion circular pitch, in.	6.2832	7.2257	—	
Pinion bearings	Babbitted	Babbitted	—	
Manipulators	Front and back	Front and back	Front and back	
Manipulator motors, no. & hp	Four, 150	Four, 150	Four, 200	
Manipulator finger motors, no. & hp	Four, 50	Four, 75	One, 150	
Shear, rated section, in.	48 x 9½	62 x 6	76 x 12	
Shear drive motors, no. & hp	Two, 200	Two, 275	Hydraulic	

The 40-in. mill, part of the first plant construction program, was designed to roll blooms and slabs. Ingots from the soaking pits approach the mill over tables about 120 ft long. Throughout the mill, tables are of heavy construction, with forged steel rollers running in roller bearings and driven at speeds up to 350-400 fpm through gears and line shafts by mill motors under magnetic control.

During rolling, the ingot is handled by side guards and manipulator fingers before and after the mill, all driven by mill type motors under magnetic control.

The mill operates at speeds up to 1140 fpm.

From the mill, the steel may follow one of two paths. Blooms or slab sections may be moved laterally over a chain transfer about 35 ft to a roller table leading to a bar and billet mill. Alternately, slabs may proceed straight ahead over tables about 155 ft long to an 800-ton, 48 in. x 10 in. shear, which is driven by two 200 hp motors under push-button rheostatic control, arranged for start-stop operation. A motor-operated shear gage measures product length, while crop ends are carried by a conveyor to a crop pit.

From this shear, slabs may proceed straight ahead to the 34 in. strip mill, for direct rolling or they may move over a slab cooling bed to a slab storage yard paralleling the blooming mill.

Blooms to be further reduced into billets are cropped in a 350-ton shear driven by a 200-hp compound wound motor and capable of cutting sections up to 48 in. x 12 in. They then proceed to the 27-24-21 in. continuous mill consisting of nine two-high stands and two vertical edgers. Details of this mill are given in Table III.

The first four two-high stands are driven through gearing by a 4000-hp synchronous motor, and the next three stands, also through gearing, by a 5000-hp synchronous motor. Each of the last two stands is driven by a 2000-hp, variable speed d-c motor. Each edger is driven by a 250-hp, 230-volt d-c motor.

The motors driving stands No. 8 and 9 receive power

In the billet mill, blooms up to 8 in. x 8 in. (or equivalent) section are reduced to 2½, 3 or 4 in. square billets, slabs up to 12 in. wide, or flats up to 16 in. wide.

TABLE III

Bar and Billet Mill Data

Stand	Roll diameter, in.	Roll body length, in.	Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll, rpm	Roll surface speed, fpm
				Hp	Voltage	Type	Rpm			
1	26 1/4	54	—					11.0	12.6	89
2	26 3/4	54	13-3 3/4					8.83	15.7	111
3	27	54	10-3 1/16	4000	6600	Synchronous	138.5	6.7	21.	148
Edger	31	12	8-2 1/2	250	230	d-c	300/900	11.5	14.3/42.9	97/292
4	27 1/4	54	8-2 1/2					4.98	27.8	196
5	24 3/4	54	13-7 1/16					7.5	40.	252
6	24 3/4	54	10-1 1/8	5000	6600	Synchronous	300	5.81	51.6	325
Edger	31	12	8-2 1/2	250	230	d-c	300/900	7.4	22.3/66.9	153/455
7	24 3/4	54	8-6 1/2					4.37	68.8	433
8	21 3/4	24	13-6	2000	600	d-c	95/525	4.6	20.6/114	113/627
9	21 1/2	24	13-0	2000	600	d-c	95/535	3.16	30/169	165/931

from a 600-volt d-c constant potential bus connected to two 5000-kw motor-generator sets which also furnish power for the finishing stands of the 34-in. strip mill.

All roll necks run in babbitted bearings. The first seven stands are equipped with screwdowns operated by 10 hp mill-type motors. The last two stands have manual screw adjustment.

The billet mill takes sections up to 8 in. x 8 in. (or equivalent) from the 40 in. mill, and reduces them to 2½, 3 or 4 in. square billets, slabs up to 12 in. wide, or flats in widths up to 16 in. and thicknesses down to ¼ in.

As material leaves the last stand of the mill, it is cut to the desired lengths by a rotary flying shear located 44 ft beyond the last stand. This shear is driven by four 190-hp, 300-volt shunt motors under variable voltage control. The cut lengths are then carried by tables either to a piler or to two skid type cooling beds 65 ft long x 30 ft wide in the billet yard. At the exit of the cooling beds there is a cold shear driven by a 75 hp induction motor.

The pilers, cooling beds and shear are located in a billet storage yard which also houses the billet storage racks supplying the merchant mills. An adjacent building contains equipment for cleaning billets.

No. 2 blooming mill, a 46-in. high lift unit, parallels No. 1 bloomer some 450 ft away. This mill was installed in 1938 primarily to roll slabs for the 96 in. strip mill.

Ingots from the pits previously described are deposited on the mill approach table about 65 ft from the mill.

The 46-in. mill has a maximum roll lift of 66¼ in., enabling it to roll slabs up to 62 in. or even 64 in. wide. Each 150 hp screwdown motor drives both mill screws through a double worm arrangement designed to give the high lifting speed of 30 fpm. Screwdown motors operate under variable voltage control.

The heavily constructed manipulator, with side guards and fingers on both sides of the mill, is driven by four 150 hp and four 75 hp motors, all under variable voltage control. Front and back mill tables are each driven by two 150 hp motors, also controlled by variable voltage.

The 46-in. mill is driven by a 7000-hp motor under the conventional variable voltage control, and attains speeds up to 1125 fpm.

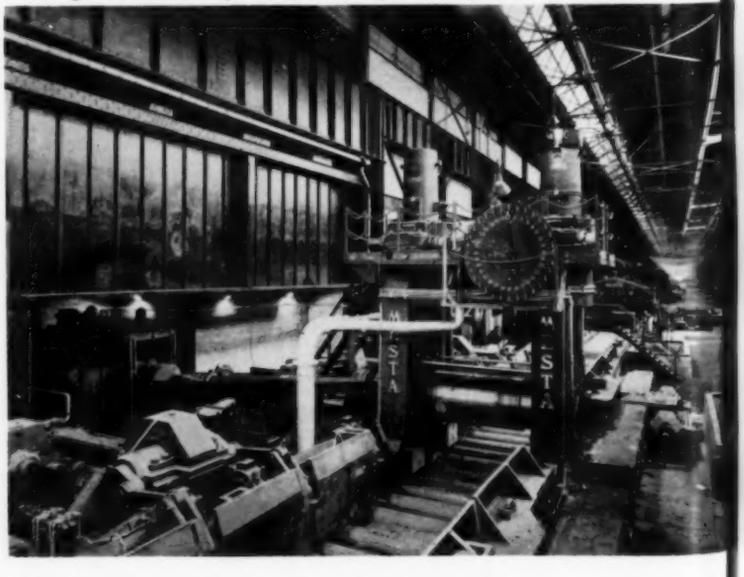
Mill auxiliaries operate under variable voltage control, receiving power from two motor-generator sets, each consisting of one 250-kw, 250-volt d-c generator, three 135-kw generators and an 800 hp drive motor.

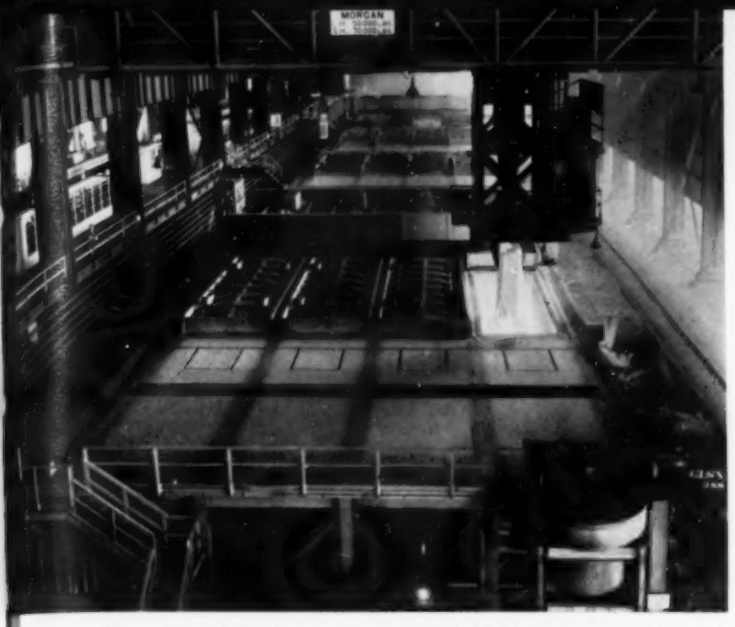
Leaving the mill, slabs are moved to a shear 115 ft beyond, designed to cut slabs up to 64 in. x 6 in. It is of start-stop type, driven by two 275 hp motors under variable voltage control. A motor-driven, screw-type shear gage measures lengths up to 21 ft. Each slab may be weighed by a scale immediately following the shear. A chute and a conveyor carry crops to a crop pit.

Since No. 2 blooming mill is in line with the 96 in. strip mill, slabs may proceed straight ahead to be rolled into strip. If not, the slabs are next moved over a transfer about 15 ft wide and 80 ft long into a slab storage yard, on to another table containing three pilers of platform type with screw lifts. Piles of slabs are pulled off into skids and then moved by overhead crane.

As plant production expanded, the need for more rolling capacity led to the installation of a new 45 in. slabbing mill. This unit is a two-high, reversing universal stand designed to roll slabs 2¾-12 in. thick x 24-78 in. wide from ingots ranging from 26 in. x 38 in. (21,800 lb) to 32 in. x 78 in. (47,500 lb). The heavier, wider slabs produced on this mill enable the 96 in. strip mill to roll larger coils and to reduce broadsiding.

The 46-in. blooming mill, driven by a 7000 hp motor, is a high-lift unit capable of rolling slabs up to 64 in. wide.





The new slabbing mill is served by 24 recuperative pits fired with mixed gas of 385 Btu per cu ft.

The new soaking pits are equipped with a complete layout of automatic controls for temperature, fuel-air ratio and furnace pressure.

Ingots are heated in 24 pits, 25 ft long x 8 ft 6 in. wide x 12 ft 9 in. deep, arranged in six rows, each containing four pits. Each pit is fired with 385 Btu per cu ft mixed gas through a single burner near the top of one end wall. The flame travels over the tops of the ingots, makes a U-turn and exits through ports at the bottom of the burner end wall. Air for combustion is heated to 1100-1300 F in a refractory tile recuperator and a tubular steel recuperator in series. A 4300-cfm, 40 oz per sq in. fan provides air to each block of pits. Automatic controls regulate temperature, fuel-air ratio and furnace pressure on each pit.

Ingots are charged at temperatures of about 1200 F. Heating time averages about 10 hours and fuel consumption runs 881,000 Btu per ton of ingots.

Ingots are charged and drawn by two 25-ton pit cranes. Heated ingots are moved by ingot car to the ingot receiving table. This car is controlled from the soaking pit floor and attains speeds up to 600 fpm. The mill approach table contains a motor-operated, overhead type ingot turnaround and a 30-ton scale and weight recorder.

Details of the slabbing mill are given in Table II.

The vertical rolls, which are located 8 ft 3 in. beyond the horizontal rolls, may be adjusted to give a maximum opening of 90 in.

Movable side guards on both sides of the mill are operated through racks and pinions by four 200-hp d-c motors. Manipulator fingers, driven by one 150-hp motor, are installed on the discharge side only.

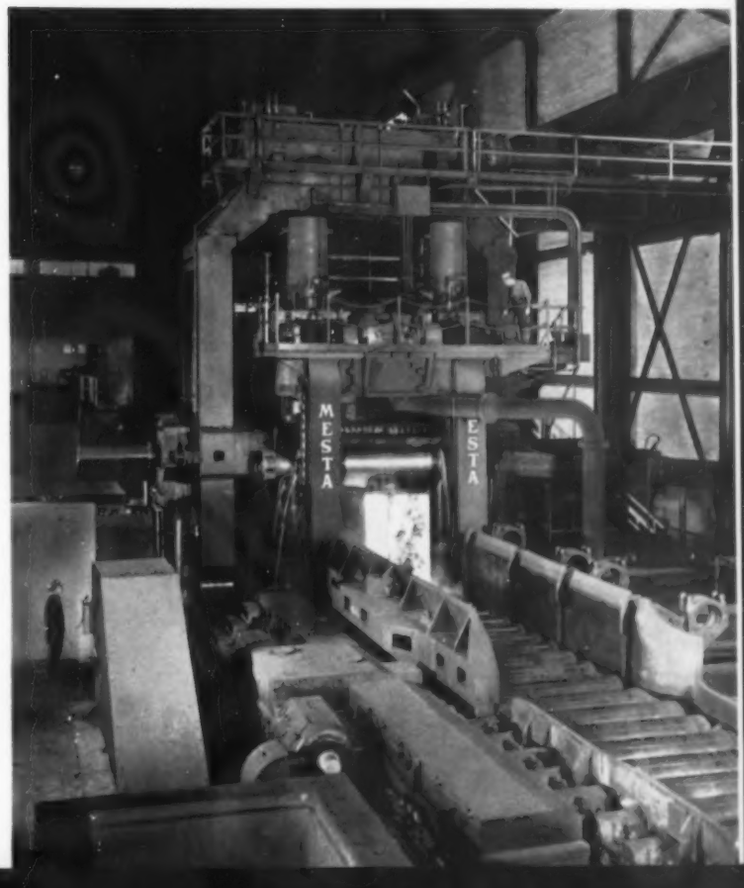
Six feed rollers individually driven by 17 hp d-c motors are arranged with two rollers in front of the horizontal mill. Two between the horizontal and vertical mills, and two on the exit side of the vertical mill. Front and back mill tables are 34 ft 11 in. long and are each driven by two 200-hp motors. Table speeds range up to 267 fpm.

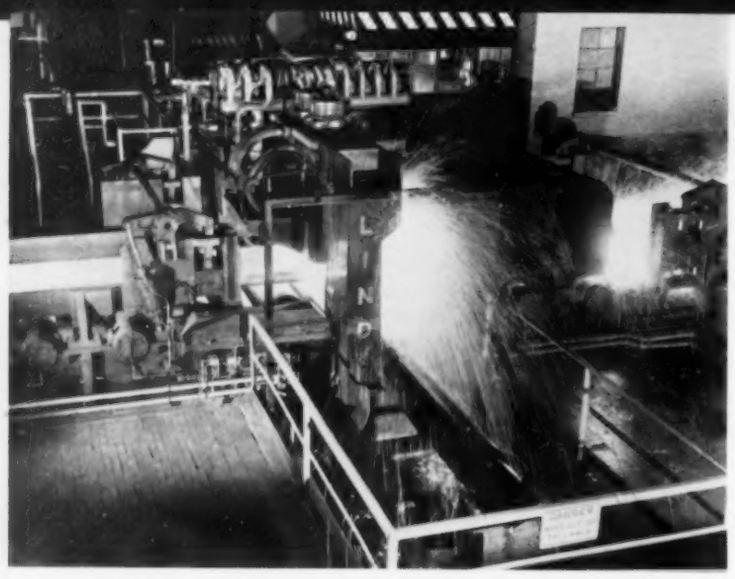
The drive on this mill is one of the most powerful installed to date. Each horizontal roll is driven by a 6000 hp double armature, direct connected, reversing motor in twin drive arrangement. Each motor is provided with two pedestal type, ring lubricated, split sleeve bearings. A heavy duty thrust bearing is applied on the coupling and pedestal, and a light duty thrust bearing with oscillation damper is used on the opposite pedestal.

The vertical rolls are driven through right-angle reduction gears by a 4000-hp double armature motor which is mounted 33 ft 6 in. above the floor on a reinforced concrete pedestal.

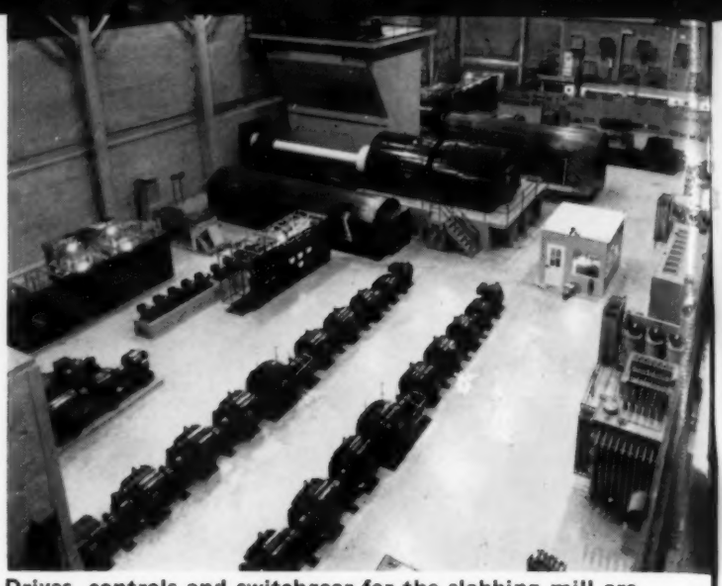
Armatures of the three roll drive motors are connected in three separate series loops, each consisting of two motor armatures and two generators interposed so that voltage to ground is the voltage across one armature only. This arrangement minimizes possible short circuit current and reduces the number of circuit breakers required. Load balancing is eliminated, except for that required between the loops associated with the top

The 45 in. x 90 in. universal-slabbing mill, designed to produce slabs up to 12 in. thick and 78 in. wide, is driven by three motors totaling 16,000 hp.





This gas scarfing machine removes 1/32-1/8 in. from top and bottom of the slab as it travels along the slabbing mill runout table at speeds of 80-160 rpm.



Drives, controls and switchgear for the slabbing mill are housed in this motor room. The 4000-hp motor driving the vertical rolls is elevated on a pedestal. The two 6,000 hp motors driving the horizontal rolls are immediately below.

and bottom horizontal rolls, which is done by rotating regulating exciter control of the main exciters.

The voltage regulator can be set for reversal from base speed in one direction in one second, but a 1.5 second reversal seems better suited to normal operations.

Auxiliaries of the 45-in. mill, including front and back mill tables, feed rollers, screwdown drives and manipulators operate under variable voltage control, with power coming from two motor-generator sets, each carrying five 200-kw generators, two 150-kw generators and two 100 kw generators, and driven by a 1250 hp, 1200 rpm, 6600 volt synchronous motor.

Mill runout and shear approach tables are also operated under variable voltage control, with power coming from a motor-generator set consisting of four 100-kw, 250-volt generators driven at 1800 rpm by a 400 hp, 440 volt induction motor.

Following the mill at a distance of 126 ft is a gas scarfing machine containing 144 nozzles. As the slab moves through the machine at speeds of 80-160 fpm, 1/32-1/8 in. of stock is removed from the top and bottom.

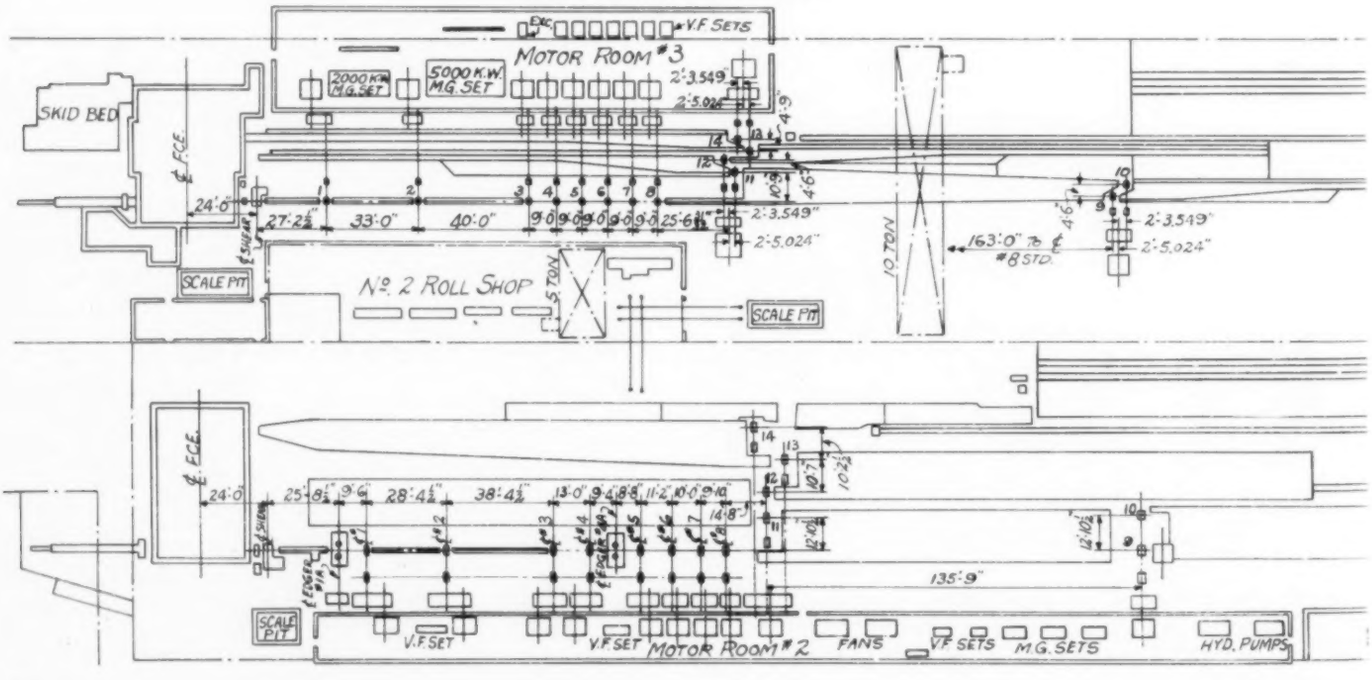
About 83 ft farther is a 2800-ton upcut hydraulic shear capable of cutting slabs up to 12 in. thick x 76 in. wide. The shear is equipped with a motor-operated shear gage that will measure lengths of 3 ft 9 in. to 20 ft 9 in. Crops pass down a chute to a heavy conveyor which carries them to a crop pit.

As in the other two blooming mills, mill scale is flushed into a pit from where it is loaded into a railroad car by bucket crane.

The 45-in. mill, with its drives and auxiliaries, is lubricated by three recirculating oil systems, six automatic grease systems and thirteen manual grease systems.

Slabs leaving the shear are pushed off the table on to two transfers 16 ft wide x 34 ft long leading to a parallel table. Other pushers move the slabs to rack-driven elevator pilers. The pilers are located in an adjacent slab yard (No. 4) 750 ft long x 106 ft wide, served by two 75-ton cranes. Slabs are moved to the strip mill by rail.

Layout of merchant mills.



MERCHANT MILLS

Two merchant mills provide facilities for a wide range of rolled products in the smaller sizes.

The 14 in. mill takes billets 2½, 3, 4, 6 and 7 in. square, 7½ in. x 8½ in. and various sizes of slabs from 2½ in. x 4 in. up to 2½ in. x 14 in. Billets are 25-30 ft long except for the heavier sizes, which are about 15 ft. The mill produces rounds and squares 1-4½ in., flats from ¼ in. x 1½ in. up to 14 in. wide in various thicknesses. In addition, a wide assortment of special sections is rolled, including T-bar for brake bands and sections for bumpers, rims, etc.

The billet yard at the exit of the billet mill also serves as the stock yard for the merchant mills. Billets or slabs are carried by magnet cranes to the skid beds, transferred to roller tables which convey them to the heating furnaces for the merchant mills.

Billets are heated in a 33 ft x 50 ft end charged, side discharged, continuous recuperative furnace, rated at 40 tons per hr on steady runs. This furnace is fired with mixed gas or oil and is equipped with automatic combustion control. A guillotine type shear near the furnace outlet divides the billet if so desired.

The 14-in. mill consists of 14 stands of rolls with vertical edgers preceding No. 1 and No. 5 stands. Some details are shown in Table IV. The first eight stands from a continuous roughing train, while the last six stands are located in crosscountry pattern. Rolled material may leave the mill from stands No. 9, 12 or 14. Cooling beds are located after No. 12 and No. 14 stands. No. 9 stand, which is in line with the roughing train, is the finisher for strip, 6-14 in. wide, and is followed by a rotary flying shear and a runout table to a piler.

A bar from No. 8 stand may be moved on to No. 9 and No. 10, and back to No. 11 stand, or it may be transferred directly from No. 8 to No. 11. Thus, No. 9 and 10 stands may become intermediate roughers for bars finishing out of No. 12 or No. 14, or they may remain idle if the reduction schedule permits. From No. 8 stand on, all bars may be handled by transfer tables or, when size permits, may be looped through stands No. 11, 12, 13 and 14.

This 21-18-14 in. merchant mill produces rounds and squares 1-4½ in., flats from ¼ in. x 1½ in. up to 14 in. wide in various thicknesses, and a wide range of special sections.

No. 14 stand is the finisher for rounds 1-2½ in. in diameter, related hexagons, squares from 15/16 to 2 9/16 in., flats from 1¾ in. to 6 in., and the smaller sizes of special sections. No. 12 stand is the finisher for the heavier flats and for 2½-4½ in. rounds and squares. Bars requiring sawed ends are also finished from No. 12 stand, and are carried on a runout table to the hot saw. The saw is served by two short cooling beds, but can also use the 38 ft x 120 ft cooling bed.

Bars finishing out of No. 12 stand that do not require sawing continue out the runout table to a 35 ft x 120 ft cooling bed for which they are moved over a table containing two shears. This same shear run handles product finished out of No. 14 stand. Flats which require pack annealing are finished on to the 14 ft x 250 ft cooling bed at No. 14 stand.

The mill layout gives flexibility, as, with proper scheduling, many roll changes can be made on idle stands while the mill is operating on other sizes.

All of the main drive motors are 600-volt d-c, and draw power from a 5600 kw motor-generator set in No. 3 motor room.

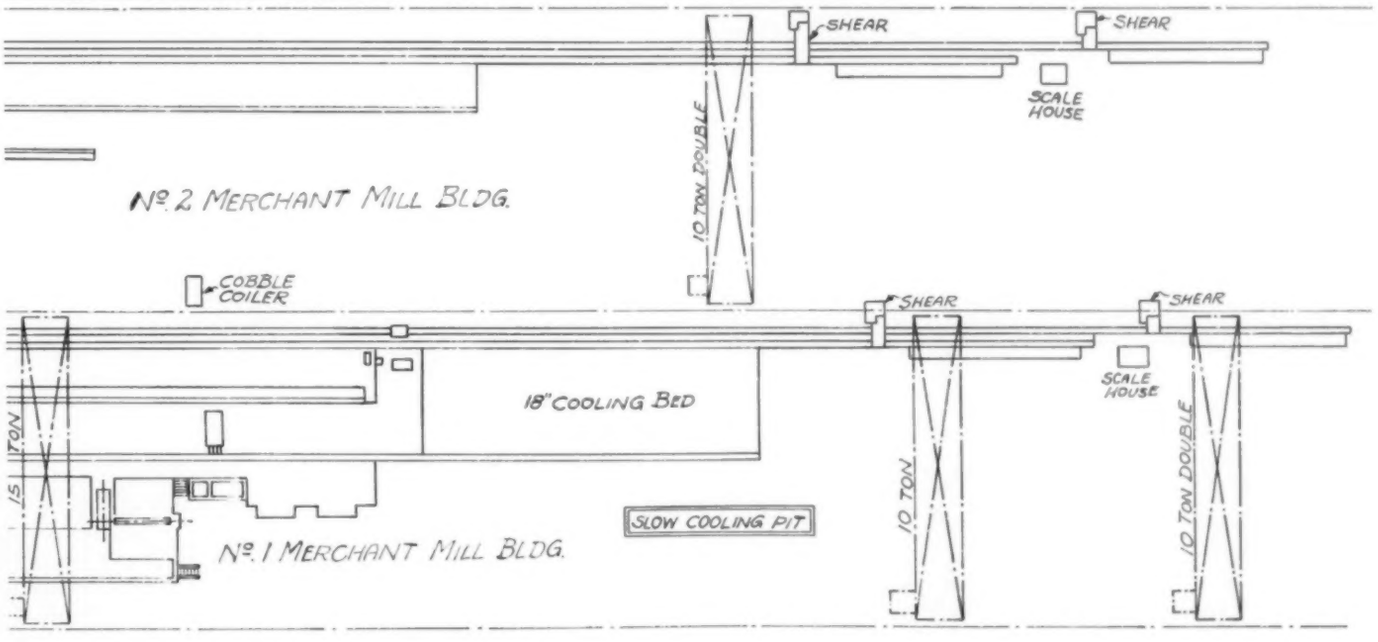


TABLE IV

Merchant Mill Data

Stand	Roll size, in.		Distance from preceding stand, ft-in.	Motor hp	Motor rpm	Gear ratio	Roll rpm	Roll face speed, fpm
	Diameter	Body length						
14 in. Mill								
Vertical edger	—	—	—	100	300/900	—	7.16/21.48	40.3/120.9
No. 1	21 3/8	40	9-6	300	150/300	12.6	11.9/23.8	66.6/133.2
No. 2	21 3/8	40	28-4 1/2	400	200/400	12.6	15.9/31.8	88.9/177.9
No. 3	21 3/8	40	38-4 1/2	400	200/400	10.5	19.05/38.1	106.6/213.2
No. 4	21 3/8	40	13-0	500	200/400	7.6	26.4/52.8	147.7/295.4
Vertical edger	—	—	9-4	50	550/1500	—	31.9/87.	142.9/390.
No. 5	18 3/4	36	8-8	600	300/600	7.6	39.6/79.2	194.4/388.8
No. 6	18 3/4	36	11-2	600	300/600	5.5	54.1/108.2	265.6/531.1
No. 7	18 3/4	36	10-0	700	300/750	5.5	54.1/136	266.4/665.9
No. 8	18 3/4	36	9-10	700	300/750	4.4	68.6/171.4	338.3/845.2
No. 9	18 7/8	36	150-5	1000	200/600	3.1	66/198	326.1/978.4
No. 10	18 7/8	36	—			3.1	66/198	326.1/978.4
No. 11	18 3/4	36	135-9			3.8	66.1/165.2	326.6/816.3
No. 12	18 3/4	36	—			3.8	66.1/165.2	326.6/816.3
No. 13	14 3/4	24	—	1500	250/620	2.5	99.5/248.7	384.2/960.4
No. 14	14 3/4	24	—			3.8	110.2/275.5	425.5/1063.9
10 in. Mill								
No. 1	16 1/2	32	—	300	200/400	10.29	19.44/38.88	81.4/162.8
No. 2	16 1/2	32	33-0	300	200/400	7.61	26.25/52.5	110/220
No. 3	14 3/4	32	40-0	400	200/400	6.09	32.81/65.62	123.7/247.4
No. 4	14 3/4	32	9-0	400	250/500	6.09	41.02/82.04	154.6/309.2
No. 5	14 3/4	32	9-0	400	250/500	4.38	57.07/114.14	215.1/430.2
No. 6	14 3/4	32	9-0	550	400/800	5.33	75/150	282.7/565.4
No. 7	14 3/4	32	9-0	550	400/800	3.83	104.35/208.7	393.4/786.8
No. 8	14 3/4	32	9-0	550	400/800	3.0	133.3/266.6	502.6/1005.2
No. 10	10 11/16	17	—	900	300/600	1.43	209.1/418.2	563/1126
No. 11	10 11/16	17	139-8 1/2	900	300/600	1.56	191.8/383.6	516.5/1033
No. 12	10 11/16	17	—			1.43	209.1/418.2	563/1126
No. 13	10 11/16	17	—	1000	300/600	1.27	236.4/472.7	636.5/1273.0
No. 14	10 11/16	17	—			1.15	260/520	700.1/1400.2

Except for stands No. 13 and 14, which have vitrified wood bearings, roller bearings are applied to all roll necks as well as to the pinion sets and gear drives. Two circulating oil systems lubricate the gear drives. Mill screws, 6 in. in diameter, are driven by a 2 hp motor on each stand.

Hydraulic descaling sprays, under 600 psi pressure, are located at stands No. 1, 3 and 5 to insure good product surface.

A warehouse north of the mill building houses shears, straighteners and other facilities for finishing, bundling and shipping the product from the 14 in. mill. Material is moved into this warehouse by a 60-ft, 100 ton transfer car which runs across the west end of both merchant mills and their warehouses.

The 10 in. mill is designed to reduce billets 2½ in. square or 2½ x 4½ in. into rounds or squares ⅜-1 11/32 in., flats from 5/32 in. x ¾ in. to 7/16 in. x 4 in., and special sections. Billets 25 to 30 ft long are heated in a double-fired, side-charge, side-discharge, continuous, recuperative furnace fired by fuel oil. The gas-fired furnace has a hearth 41 ft long x 33 ft wide and is equipped with automatic combustion control. A guillotine type dividing shear follows the furnace.

This mill is quite similar in layout to the 14 in. mill, with the first eight stands forming a continuous roughing train while the finishing stands are in cross-country arrangement. Table IV gives some details on this mill.

All of the mill stands are two-high. All drive motors are 600-volt d-c, and are supplied from a 5000-kw motor-generator set located in No. 3 motor room.

Babbitted bearings are used on the roll necks of the stands. Roller bearings are used in the pinions and gear sets. Two oiling systems lubricate the gear sets.

Ahead of No. 2 stands, a 600-psi hydraulic spray is provided.

A rotary flying shear follows No. 14 stand for cutting test pieces.

The only outlet from the 10 in. mill is a 13 ft x 255 ft cooling bed, which can also be used for pack annealing. A shear table is installed, similar to that on the 14 in. mill, containing two cold bar shears.

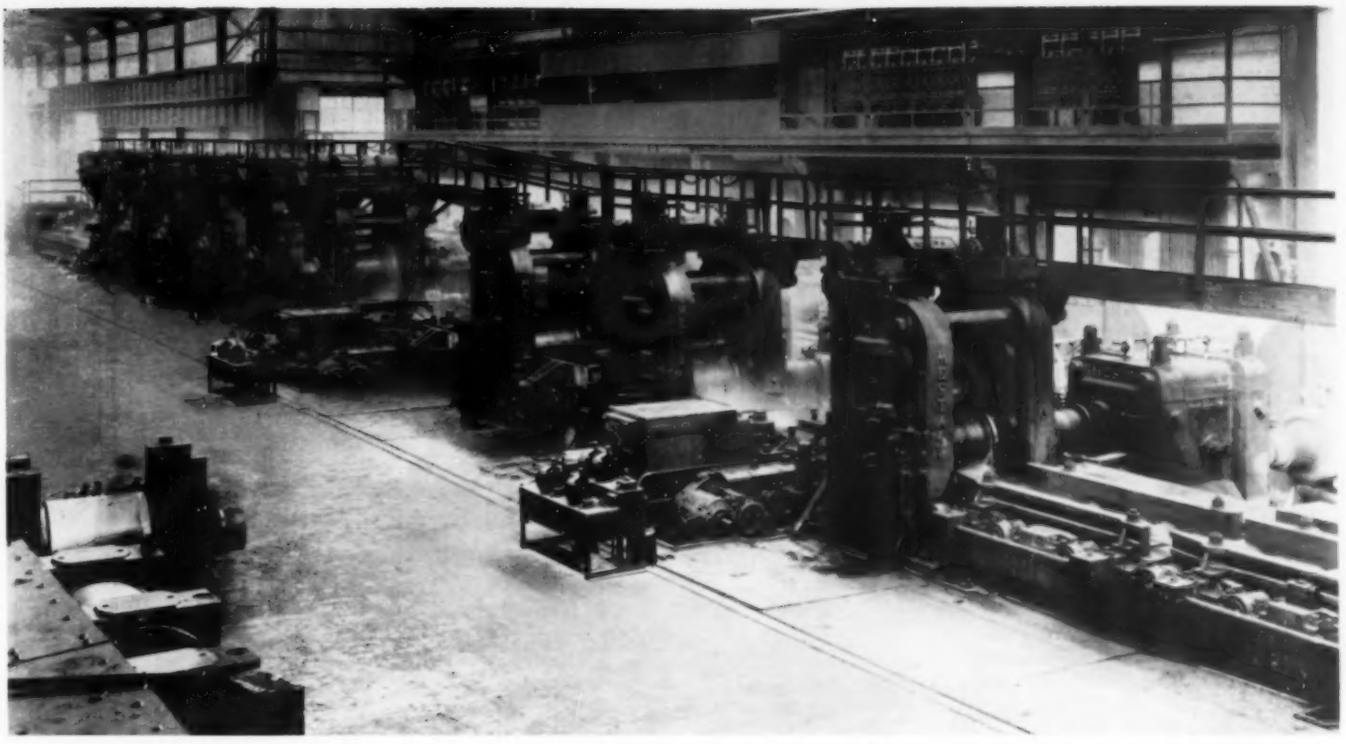
The warehouse for No. 2 merchant mill is a continuation of the 38-in. strip mill finishing building, and contains straighteners, shears, grinders, saws, etc.

STRIP MILLS

A major portion of the output of the Great Lakes plant is flat-rolled material, produced on two continuous strip mills.

No. 1 strip mill, a part of the original construction project, is a 34-in. unit consisting of ten roll stands and three edgers. It rolls products ranging from .437 in. down to No. 16 gage in thickness.

Slabs from No. 1 slab yard, 2½-3 in. thick, are moved by crane to a magazine elevator feeder which in turn moves one slab at a time on to a 156 ft charging table



All stands of the 34-in. strip mill are closely grouped, necessitating variable speed drive motors for all stands.

running across the back ends of the slab heating furnaces. Rack and pinion type pushers move slabs from the charging table and through the furnaces.

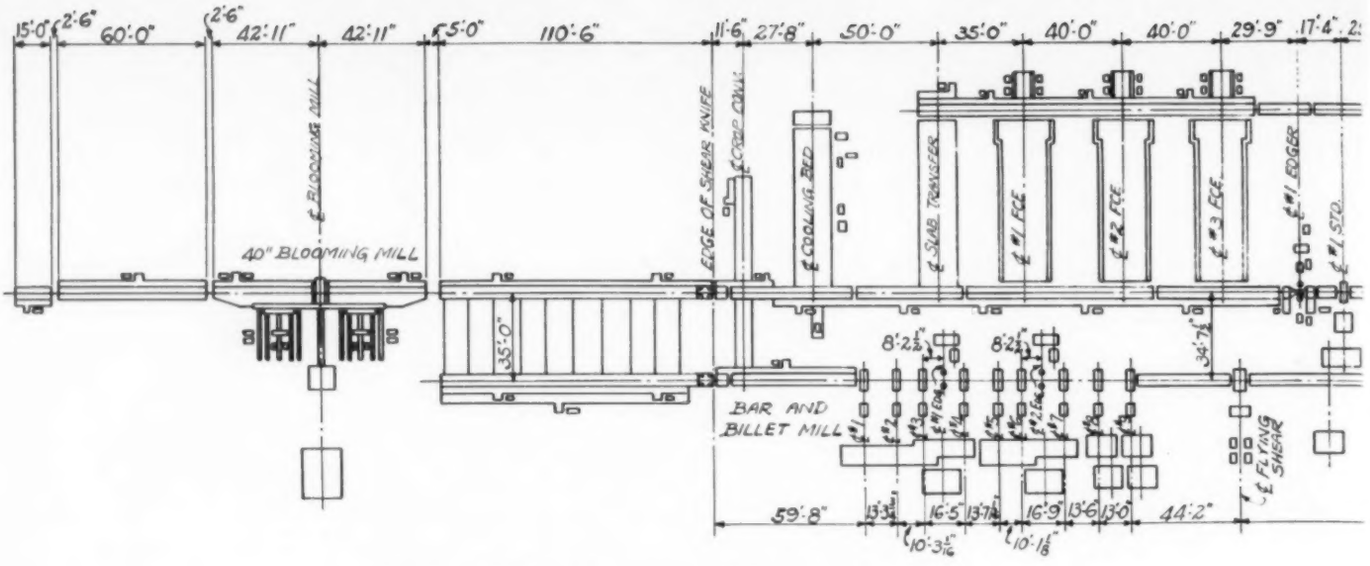
Three continuous recuperative furnaces, each rated at 40 tons per hr, heat slabs for the 34-in. mill. These furnaces have hearths 55 ft 8 in. long x 18 ft wide, and are each fired by fuel oil or mixed gas through six burners top and bottom. Fuel consumption averages about 3,000,000 Btu per ton.

At rolling temperatures averaging about 2050 F, slabs are expelled from the furnaces by action of the furnace pushers, and slide on to the mill approach table,

TABLE V

Strip Mill Data

Stand	Work roll		Back-up roll		Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll rpm	Roll face speed, fpm
	Diameter, in.	Body length, in.	Diameter, in.	Body length, in.		Hp	Volt-	Type	Rpm			
34-in. Hot Mill												
Vertical edger	31	12½	—	—	—	250	600	d-c	300/900	—	2.38/35.7	—
No. 1 Rougher	24	38	—	—	17-4	1200	600	d-c	23/225	9.0	2.56/25	14.2/157
No. 2 Rougher	24	38	—	—	25-10	1600	600	d-c	42/300	9.0	4.67/35.6	29.4/224
Vertical edger	23	6¼	—	—	—	150	600	d-c	465/1400	—	17/512	—
No. 3 Rougher	24	38	—	—	17-6	2200	600	d-c	50/500	9.0	5.56/50	35/315
No. 4 Rougher	24	38	—	—	16-1	3000	600	d-c	48/450	5.1	9.4/88.3	59.2/556
Vertical edger	23	6¼	—	—	—	150	600	d-c	465/1400	—	17/512	—
No. 5 Finisher	18½	38	37	37	27-8	2000	600	d-c	250/500	7.38	33.9/67.8	164/328
No. 6 Finisher	18½	38	37	37	14-0	2000	600	d-c	250/500	4.6	54.3/108.7	263/526
No. 7 Finisher	18½	38	37	37	14-0	2000	600	d-c	250/500	3.16	79.1/158.2	382/764
No. 8 Finisher	18½	38	37	37	14-0	2000	600	d-c	250/500	2.5	100/200	484/968
No. 9 Finisher	18½	38	37	37	14-0	2000	600	d-c	250/500	2.0	125/250	605/1210
No. 10 Finisher	18½	38	37	37	14-0	2000	600	d-c	250/500	1.67	150/300	725/1450
96 in. Hot Mill												
No. 1 Scalebreaker	24¾	80	—	—	—	1000	6600	Ind.	300	6.36	47.1	300
No. 1 Rougher	36	100	51	90	31-4	3000	6600	WR	150	7.846	19.1	180
No. 2 Rougher	26½	98	53	90	44-3	3000	6600	WR	514/320	7.80	66.0/41	458/285
No. 3 Rougher	26½	98	53	90	46-6	3000	6600	WR	514/320	7.80	66.0/41	458/285
No. 4 Rougher	27	98	53	90	70-6	3000	6600	WR	514/320	7.80	66.0/41	466/291
No. 2 Scalebreaker	25½	94	—	—	109-2	500	600	d-c	150/600	10.44	14.3/57.4	96/384
No. 5 Finisher	26½	98	53	90	12-9	4500	600	d-c	125/250	3.783	33/66	229/458
No. 6 Finisher	26½	98	53	90	18-0	4500	600	d-c	125/250	2.261	55.2/110.4	388/767
No. 7 Finisher	26½	98	53	90	18-0	4500	600	d-c	125/250	1.551	80.6/161.2	559/1118
No. 8 Finisher	26½	98	53	90	18-0	4500	600	d-c	125/250	1.193	104.8/209.6	727/1454
No. 9 Finisher	26½	98	53	90	18-0	4500	600	d-c	125/250	Direct	125/250	867/1734
No. 10 Finisher	26½	98	53	90	18-0	3000	600	d-c	175/350	1193	146.7/293.4	1017/2035



Layout of 40-in. bloomer and 34-in. hot strip mill.

which is 126 ft long. This table is a continuation of the 40-in. blooming line, so that direct rolling is possible when desired.

The 34-in. mill consists of four two-high stands, six four-high stands and three separate vertical edgers which precede stands No. 1, 3 and 5, respectively. Details of the mill are given in Table V. It is to be noted that the layout of this mill differs from modern convention in that the mills are closely grouped. Thus, all stands are driven by variable speed motors. Seven loopers, one following stands No. 3, 4, 5, 6, 7, 8 and 9, are installed, each driven by a 25 hp torque motor. Since no broadside rolling is done, there are no turntables, slab squeezer or pushers on the mill.

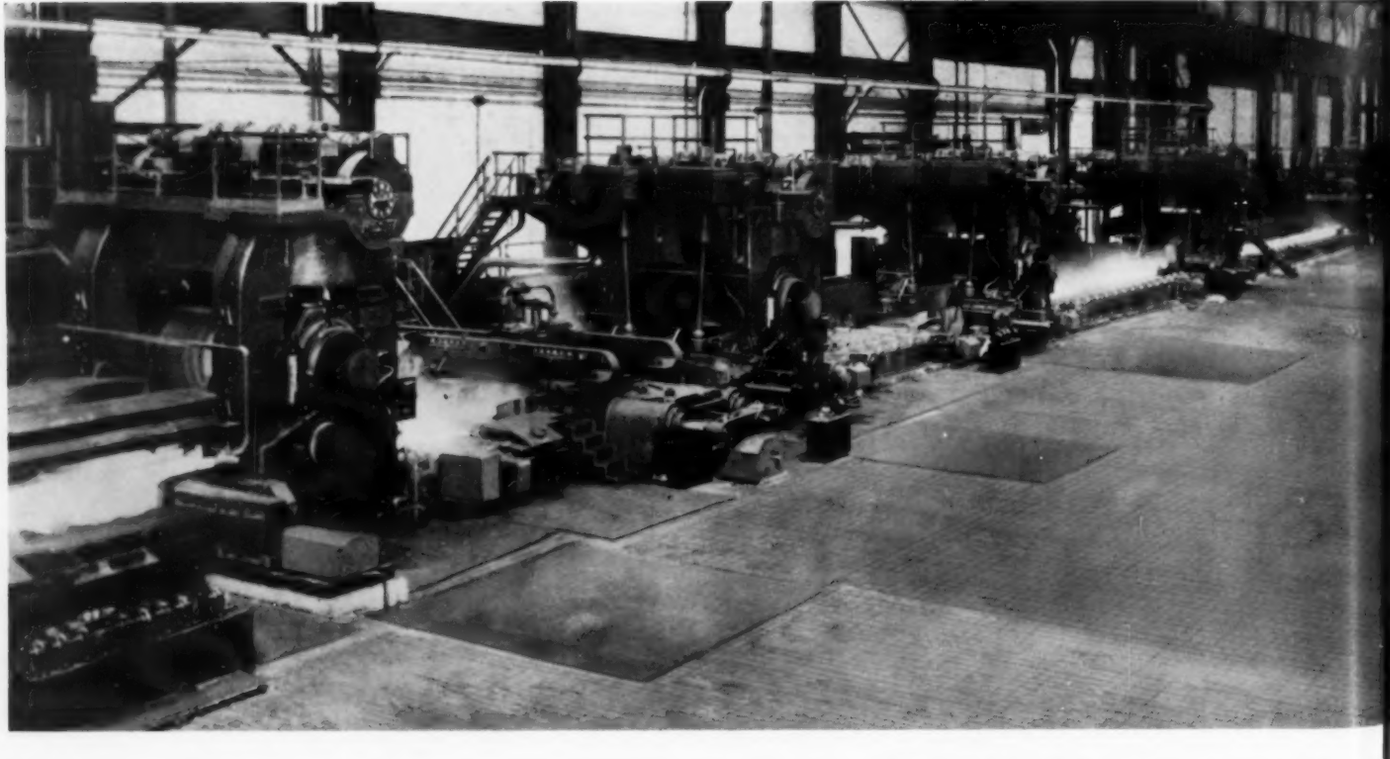
Mill screws on each of the first four stands are driven by one 10 hp motor, and one 25 hp motor operates finishing stand screws.

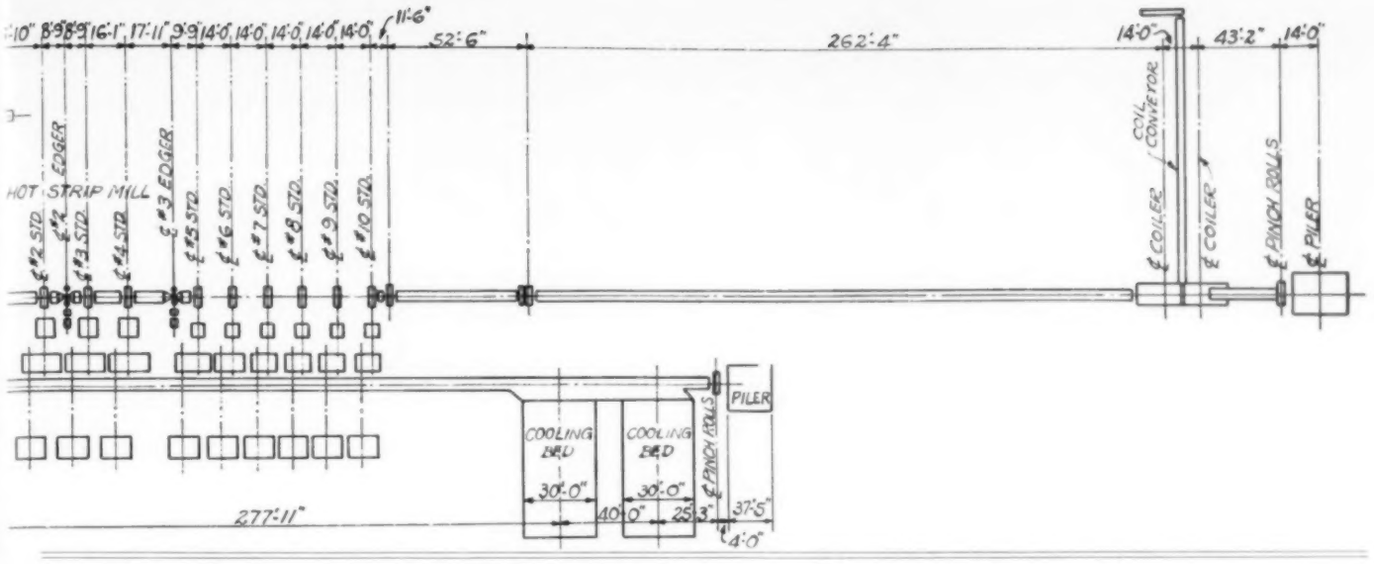
In the two-high stands, roll necks operate in bronze bearings. Roller bearings are used on the necks of work rolls and backup rolls of the four-high stands and on vertical edger roll necks. Roller bearings are also used on all pinion stands, gear drive sets and table rollers.

As an aid to good product surface, hydraulic descaling sprays are installed on the entry sides of stands No. 1, 2, 3 and 5, and on the exit sides of stands 5 and 8. Water comes from three centrifugal pumps rated at 600 gpm, 1000 psi.

Following the mill at distances from No. 10 stand of

Roughing stands of the 96-in. strip mill are spaced out in conventional layout, and are driven by 3000-hp induction motors.





11 ft 6 in. and 64 ft, respectively, are two rotary flying shears, each driven by a 125 hp motor under variable voltage control.

From the mill, the runout table, with individually driven rollers, extends for a distance of about 380 ft to a piler for cut lengths. Near the end of this table are two hot coilers. A conveyor moves the coils into a coil storage and pickling building which parallels the mill building.

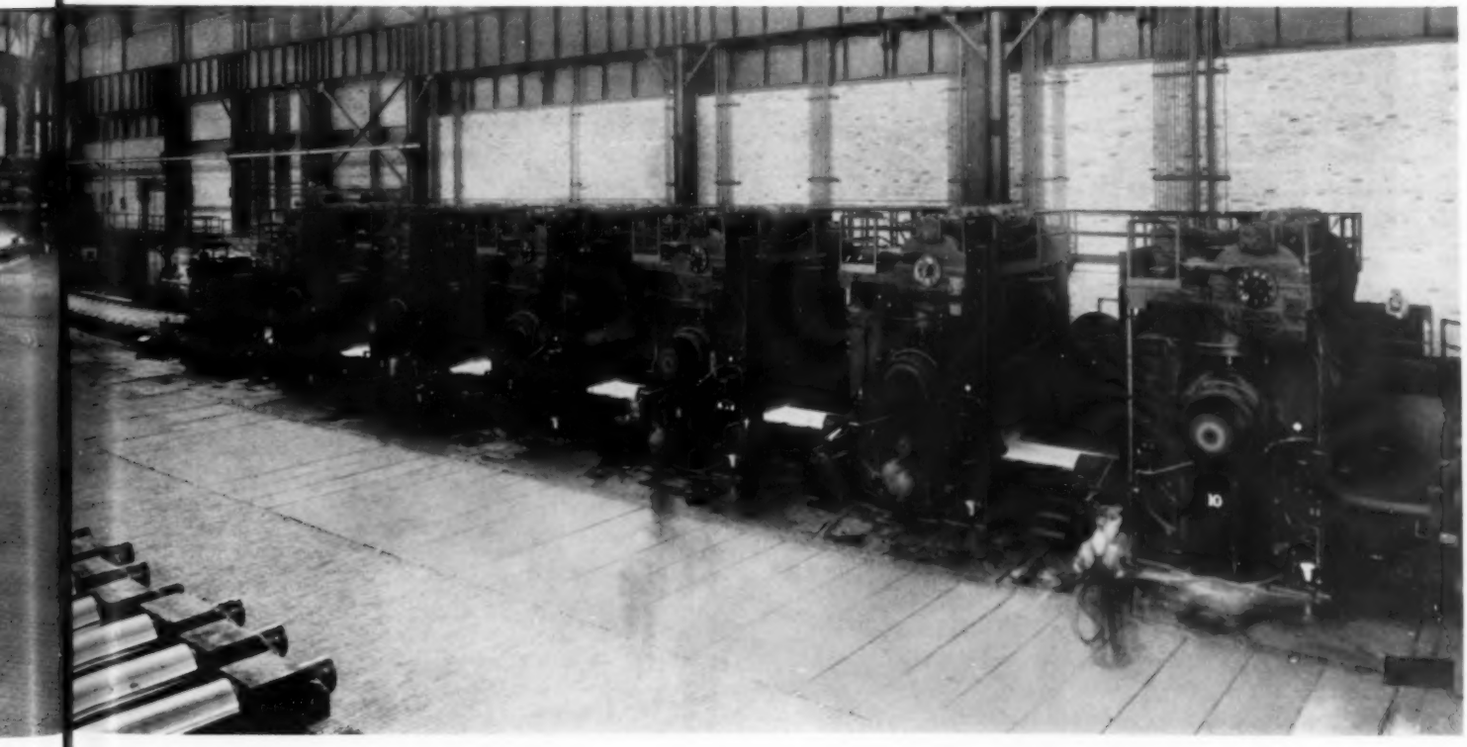
Temperature of the strip as it passes through the mill is checked at the exit sides of No. 1 and 9 stands, and just ahead of No. 1 coiler.

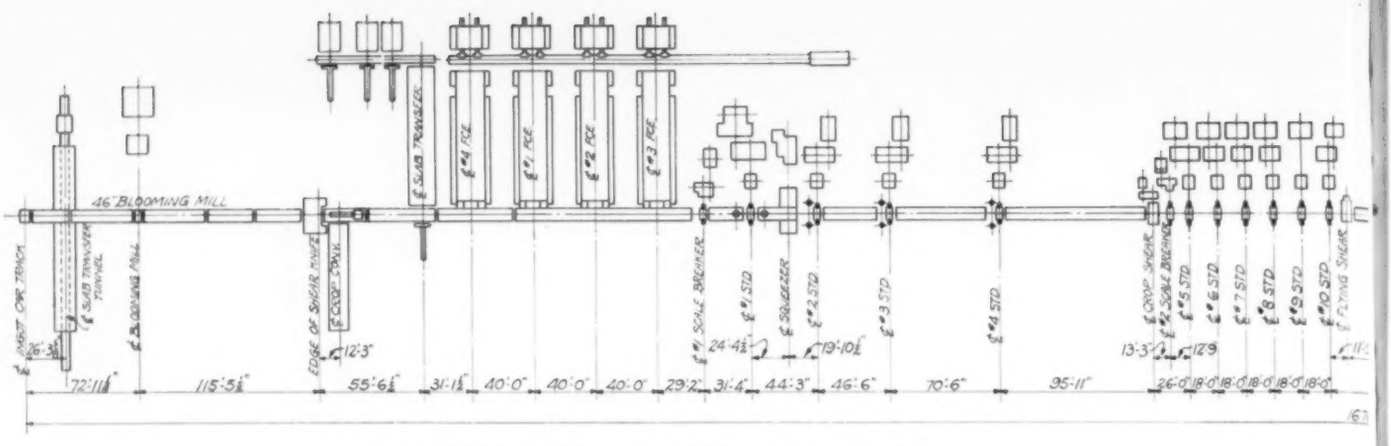
Main drive motors, motor-generator sets, control equipment and switchgear for the 38-in. mill are housed in a motor room (shared with the 40-in. bloomer and the billet mill) extending along the north side of the mill building. Drive motors for the four roughing stands draw power from a motor-generator set consisting of two 2500-kw, 600-volt d-c generators driven at 360 rpm by a 7000 hp, 6600-volt synchronous motor. The six finishing stand motors are supplied by two duplicate sets which, as previously mentioned, also supply the last two drives of the billet mill. The rougher motors are operated under variable voltage control while the finishing drives are rheostatically controlled from a 600-volt constant potential bus.

Also located in the motor room are two variable frequency sets for runout table motors, a 20 kw set for the looper motors, exciter sets, etc. There are also two special generators for the flying shears, one driven by the 2000 hp motor driving stand No. 9 and rated at 104/52 kva, 312/156 volts, 41.6/20.8 cycles; the other, rated at 125/62.5 kva, 375/187.5 volts, 41.6/20.8 cycles, driven by the 2000 hp motor on No. 10 stand.

This motor room also contains the main motors of the 40 in. bloomer and the billet mill, gear drives for

Finishing stands of the 96-in. mill are spaced on 18-ft centers. Strip as light as No. 16 gage leaves the mill at speeds up to 2035 fpm.





Layout of 46-in. bloomer and 96-in. hot strip mill.

the billet mill, motor-generator set for the 40-in. mill two 2000-kw sets for auxiliary d-c power, descaling pumps for the 34-in. mill and four 30,000,000 gal per day service water pumps.

At the end of the 34-in. mill are three 42-in. cut-up and leveler lines and a 46-in. slitting and cutting line. A parallel building, to which coils are carried by chain conveyor through an underground tunnel, contains strip finishing equipment, including one normalizing furnace, a four-arm plunger type pickler and a 36-in. continuous pickling line, as well as four 42-in. cut-up lines, five slitting lines, and a resquaring shear. This building also serves as a shipping building.

With the evolution of the wide strip mill and the increasing demand for wider sheets, it became evident that additional facilities were required. Accordingly, a 96 in. hot strip mill and complementary cold mills were installed and put into operation in 1936.

The 96-in. hot strip mill is south of and parallel to the 34-in. strip mill, and is in line with the 46-in. slabbing mill. It is designed to reduce slabs up to 6 in. thick down to strip in gages as light as No. 16. Plate up to 1 or 1½ in. thickness are also produced.

From storage, slabs are brought by overhead crane to a magazine unpiler from which a pusher moves one slab at a time on to the furnace charging table extending 228 ft across the back ends of the furnaces. Each furnace is equipped with a double rack-and-pinion type pusher, driven by two 50-hp motors, which moves slabs through the furnace in either single or double row.

Heating facilities for this mill consists of four continuous triple-fired furnaces, with hearths 76 ft 9¾ in. long x 18 ft wide. About 15 or 16 ft of the hearth length is in a soaking zone. These furnaces are fired with fuel oil or mixed gas. Six burners top-fire the heating zone, six bottom-fire the heating zone, and six more top-fire the soaking zone.

Each furnace is well insulated and encased in steel plate, and is equipped with a tile recuperator. Automatic control is provided on fuel-air ratio, temperature and furnace pressure. Fuel consumption averages 2,300,000 Btu per ton of slabs.

Heated slabs are discharged from the furnaces through operation of the furnace pushers, and slide down chutes to the table. The furnace table and mill approach tables, 162 ft in length, carry the slab to the mill.

General details of the hot mill are given in Table V.

On each side of No. 1 rougher, which is a broadside stand for increasing width of the entering slab, there is a turn table which will turn the slab through 90 degrees so that it may be cross-rolled, then restore it to its original axis. A slab pusher at the entry side of the broadside stand assists in entering the slab between the rolls.

After broadsiding, the slab is squared up and brought to accurate width in a slab squeezer operated by a 200 hp motor.

Since the installation of No. 3 slabbing mill has made slabs available up to 78 in. wide, broadside rolling has been materially reduced. Hence, longer slabs may be used up to that width, resulting in larger hot rolled coils.

The last three roughing stands are equipped with integral vertical edging rolls ahead of the horizontal rolls. Edger rolls are driven by 150-hp, 230-volt d-c motors, synchronized to match vertical roll speeds with those of the horizontal rolls.

Between the roughing train and the finishing train is a delay table about 109 ft long.

A flying crop shear, driven by a 150-hp motor, is located between No. 2 scalebreaker and the first finishing stand to even up the leading end of the strip.

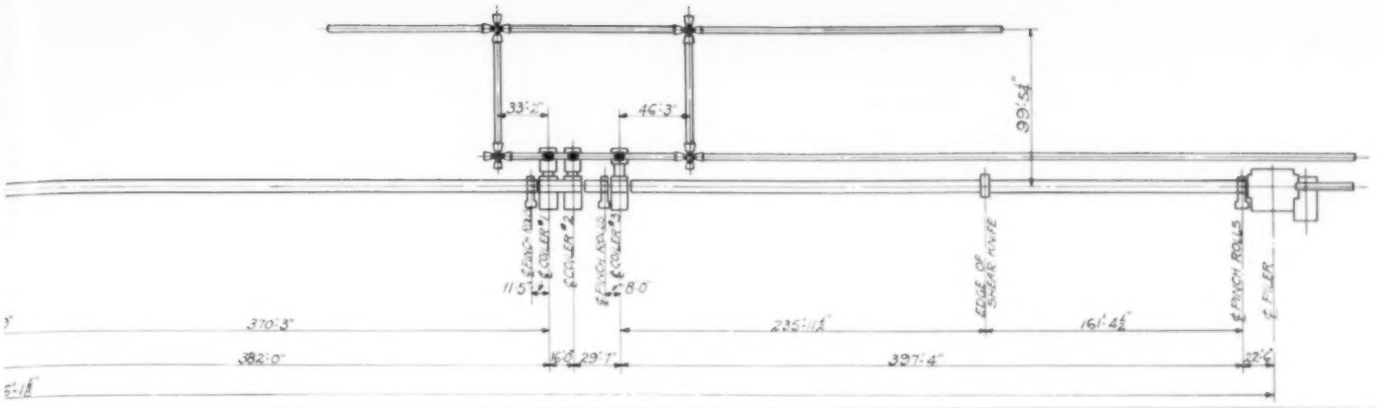
Six finishing stands, located on 18 ft centers, complete the finishing train.

Loopers are installed between the finishing stands to take up slack that may be set up in the strip as it passes through the train. Each looper is operated by a torque motor operated under variable voltage control from a 25 kw motor generator set.

Mill screws in each scalebreaker are driven by a 15-hp motor, while two 75-hp motors are used on each of the other stands, arranged for individual operation or, through a magnetic clutch, in unison.

Roller bearings are applied to the necks of all work rolls in the four-high stands, while oil film bearings are used on the necks of backup rolls and of scale-breaker rolls. Roller bearings are also used on all table rollers, which are of forged steel driven through gears and line shafts by 35 hp motors under magnetic control.

Hydraulic sprays for scale removal are located, top and bottom, on the delivery side of No. 1 scalebreaker, on both sides of No. 2 stand and on the entry side of stands No. 3 and 4, with a double spray on the delivery



side of No. 2 scalebreaker. Water comes from five centrifugal pumps rated at 1000 gpm, 1000 psi. Spray valves are pneumatically operated under solenoid control.

Radiation pyrometers measure strip temperature at the exit from stands No. 1, 4 and 9, and at the coilers.

Immediately following the finishing train is a flying hot shear, driven by two 150 hp motors. Strip leaving the finishing train may be cut into lengths as desired and then proceed over the runout table to sheet pilers some 810 ft from the last finishing stand, where overhead cranes remove the piles to cooling skids.

If coiled material is desired, the strip is passed to one of three down-coilers about 380 ft from the mill exit, each driven by one 250 hp variable voltage mandrel motor and capable of forming coils of 28 in. inside diameter, 54 in. outside diameter and up to 25,000 lb in weight.

Runout table rollers are individually driven by variable frequency motors, giving table speeds of 660-2060 fpm. Five special motor generator sets operating at 28-84 cycles, 147-440 volts, supply power to these roller drives.

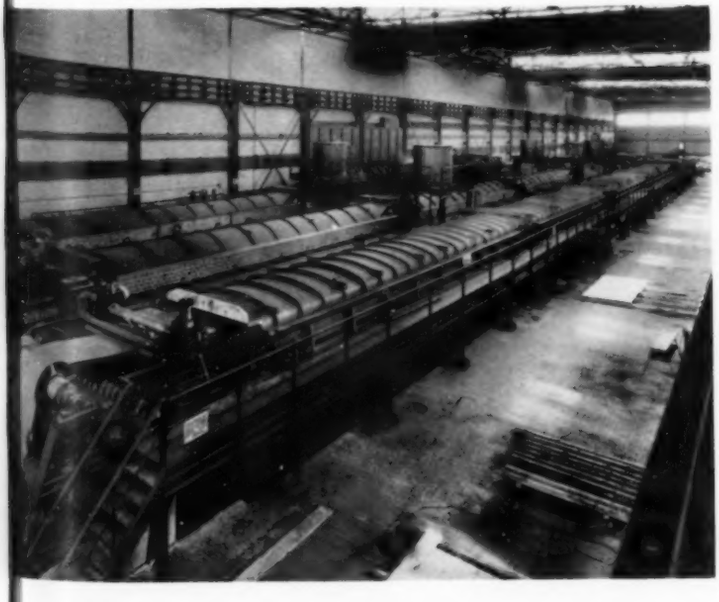
Coils are discharged from the coilers on to an underground conveyor which carries the material to a storage building.

Between the mill building and the slab yard is the motor room, housing the drive motors, gear sets, motor-generator sets, control equipment, switchgear, etc. Roughing stand motors are driven by induction motors, while finishing stand drives operate on variable voltage, receiving power from a 6000-kw, 600 volt rectifier and three motor-generator sets, each consisting of two 3000-kw, 600-volt d-c generators and an 8500 hp, 6600 volt, 360 rpm synchronous motor. The motor room is ventilated by a recirculating, down-draft system with surface type air coolers. Air circulation up to about 450,000 cfm is available.

At the end of the hot strip mill are facilities for finishing hot rolled strip, including two two-high skin pass mills (96 in. and 84 in.) for sheets, a normalizing furnace 140 ft long x 90 in. wide, a 60-in. continuous pickling line, a four-arm plunger type batch pickler, two scrubbing lines, two oiling units, an anneal and shear units, three cut-up lines, and four resquaring shears.

Cold finishing equipment is installed in seven adjacent buildings, for the most part 100 ft wide and ranging 545 ft to 1920 ft in length. They provide a combined area of about 800,000 sq ft.

Three continuous pickling lines handle strip at speeds of 75-360 fpm, removing scale prior to the cold reduction process.



COLD STRIP MILLS

Coils to be cold finished are brought from storage by overhead crane and placed on a loading conveyor which delivers them to the uncoilers of the continuous picklers. There are three of these continuous lines, about 625 ft long, each consisting of a coil feed conveyor, coil upender, tilter uncoiler and processor, up-cut shear, flash welder, flash trimmer, mechanical stitcher, pinch rolls, five acid tanks, rinse water tanks, dryer unit, pinch rolls, up-cut shear side trimmer, oiling rolls and recoiler. Each acid tank is 58 ft 4½ in. long x 8 ft 6 in. wide x 4 ft 1¾ in. deep, and holds approximately 12,000 gallons of 25 per cent sulphuric acid solution. The solution is heated to 190-215 F by steam jets. Tanks are of steel construction, covered with rubber and lined with acid-resistant brick. Tank covers are of steel, rubber covered and vented to the outside air.

Strip moves through the pickler at speeds of 75-360 fpm, and after being recoiled, is discharged on to a conveyor and moved to the adjacent cold mill building.

Cold rolling facilities include three-stand tandem mills, details of which are shown in Table VI.

Roller bearings are applied to the necks of the work rolls and oil-film bearings to the back-up roll necks. On two of the mills, the screwdown mechanism for each

TABLE VI
Cold Mill Data

Stand	Work roll		Back-up roll		Distance from preceding stand, ft-in.	Motor data				Gear ratio	Roll rpm	Roll face speed, fpm
	Diameter, in.	Body length,	Diameter, in.	Body length, in.		Hp	Voltage	Type	Rpm			
No. 1 Tandem Mill												
Stand No. 1	20½	93	53	90	—	4000	640	d-c	150/300	Direct	150/300	785/1570
Stand No. 2	20½	93	53	90	16-0	4000	640	d-c	175/350	Direct	175/350	916/1832
Stand No. 3	20½	93	53	90	16-0	(2)2000	640	d-c	200/400	Direct	200/400	1047/2094
Reel	—	—	—	—	—	800	600	d-c	150/500	1.604	—	—
No. 2 Tandem Mill												
Stand No. 1	20½	54	53	51	—	1250	600	d-c	300/600	6.36	47.2/94.4	247/494
Stand No. 2	20½	54	53	51	16-0	1250	600	d-c	300/600	4.42	67.8/135.6	355/710
Stand No. 3	20½	54	53	51	16-0	1250	600	d-c	300/600	3.38	88.9/177.8	464/928
Reel	—	—	—	—	—	150/225	600	d-c	225/900	10.0	—	
No. 3 Tandem Mill												
Stand No. 1	20½	93	53	90	—	4000	750	d-c	80/200	Direct	80/200	413/1040
Stand No. 2	20½	93	53	90	16-0	(2)2000	750	d-c	100/250	Direct	100/250	525/1310
Stand No. 3	20½	93	53	90	16-0	(2)2000	750	d-c	116/290	Direct	116/290	610/1520
Reel	—	—	—	—	—	800	600	d-c	150/525	2.125	—	—
Skin Pass Mill No. 1	20½	93	53	90	—	1250	600	d-c	300/600	5.06	59.3/118.6	311/622
Skin Pass Mill No. 2	20½	93	53	90	—	500	600	d-c	225/450	5.06	44.5/89.0	233/466
Skin Pass Mill No. 3	20½	93	53	90	—	1250	600	d-c	300/600	3.38	88.8/177.6	465/930
Skin Pass Mill No. 4	28	55	—	—	—	250	250	d-c	500/1000	12.19	41.1/82.2	300/600
Skin Pass Mill No. 5	20½	93	53	90	—	1250	600	d-c	300/600	10.44	28.7/57.4	150/300
Skin Pass Mill No. 6	20½	93	53	90	—	900	600	d-c	300/600	3.38	88.8/177.6	465/930
Skin Pass Mill No. 7	20½	93	53	90	—	1250	600	d-c	300/600	5.06	59.3/118.6	311/622

stand is driven by two 35-hp motors, while two 75-hp motors are used on each stand of No. 3 mill.

No. 1 mill drives draw power from two motor-generator sets, one of 6000 kw and one 4600 kw capacity. No. 2 mill is supplied by a 3500-kw set, while an 11,200 kw set serves No. 3 mill.

The hardness and stiffness induced in the strip by cold reduction is eliminated by annealing. For this purpose, there are 12 in-and-out batch furnaces and 64 portable cover furnaces, providing capacity for about 100,000 tons per month. The in-and-out furnaces are arranged in three batteries of four furnaces each. The boxes are charged and drawn by a charging machine which operates on a track extending along the row of furnaces.

The portable cover furnaces are of radiant tube design. The majority are designed to accommodate coiled material and will take coils 48-60 in. in diameter, piled to a height of 104-135 in. The sheet furnaces can take material 120-268 in. long and 54-90 in. wide, piled to 50-54 in. height. About 80 per cent of the material is in coil form.

Annealing cycles range 20-40 hr heating, 16-30 hr soaking, and 48-72 hr cooling time. Temperature run 1200-1300 F.

The furnaces are fired with mixed gas. Fuel consumption averages 1,800,000 Btu per ton.

Ten gas machines, with a total capacity of 150,000 cu ft per hr, provide neutral atmosphere gas to protect the stock during the annealing process.

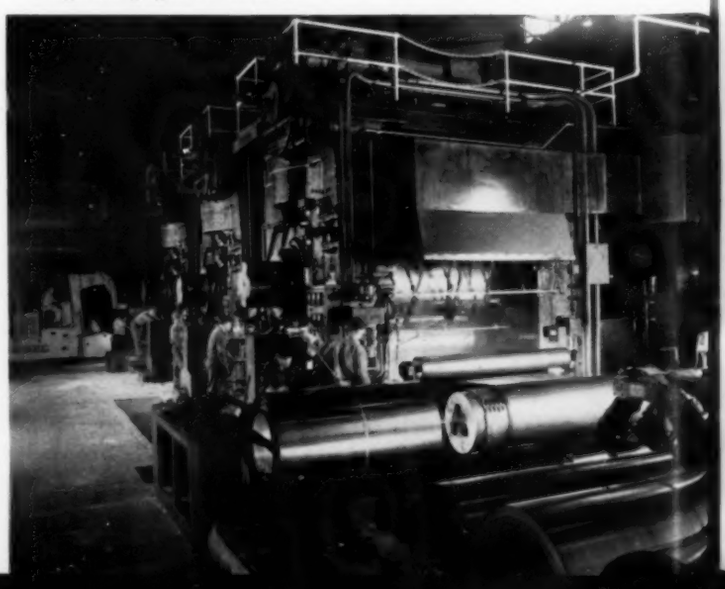
Temper rolling, to restore the desired stiffness, flatness and surface to the annealed stock, is carried out on seven skin-pass mills, details of which are given in Table VI.

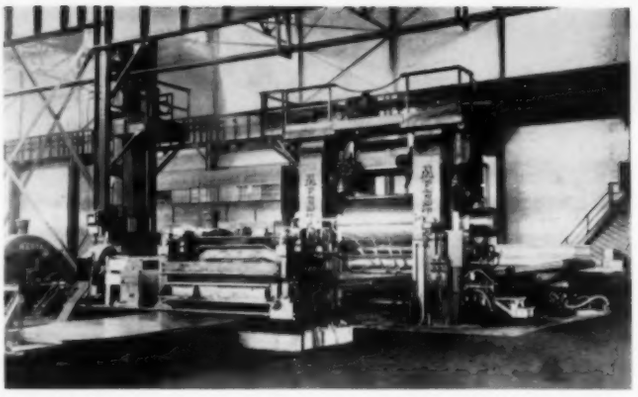
The four-high mills have roller bearings on their work rolls and oil-flooded bearings on the back-up rolls. The two-high mill is equipped with babbitted roll neck bearings.

Drive motors on the skin-pass mills draw power from two motor-generator sets. No. 1, 2 and 4 mills are served by a set consisting of two 1250-kw, 600-volt d-c generators and one 300-kw, 250-volt generator, driven by a 4000 hp synchronous motor. No. 3, 5, 6 and 7 mills are supplied by four 500-kw, 600-volt d-c generators driven by a 2900-hp synchronous motor.

Other equipment installed in the cold finishing department includes nine flying shear lines (two 60 in. wide, seven 93 in. wide), three coil trimming and slitting lines (one 72 in., two 93 in.), two roller levelers,

Three three-stand tandem cold mills (two 93 in. wide, one 54 in. wide) reduce the hot rolled, pickled strip to lighter gages as desired.





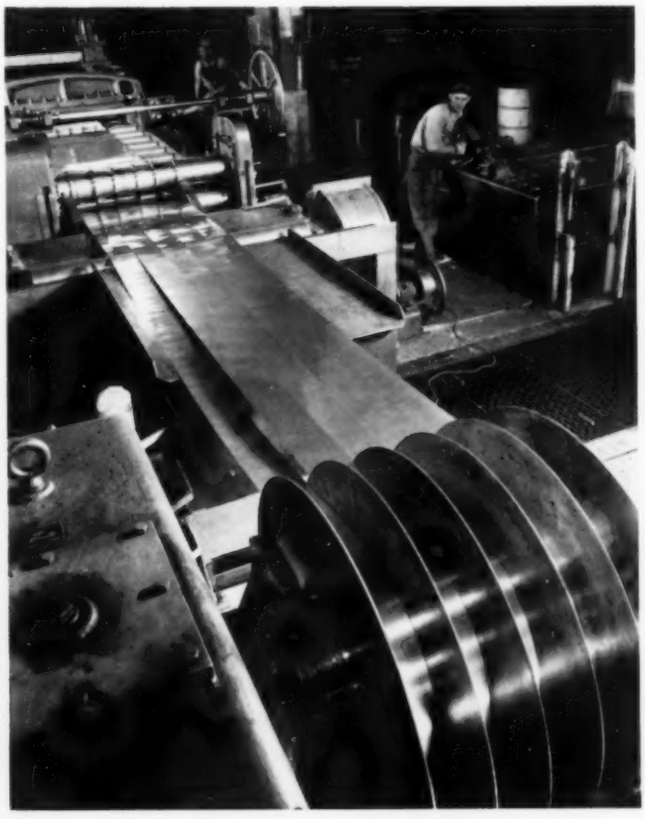
This 93-in. skin pass mill is used to effect a light reduction on annealed sheets to stiffen, flatten and improve surface finish.

one stretcher leveler, six resquaring shears, eight oiling machines.

The Michigan Steel Division, which is the original sheet mill of the early 1920's, about two miles from the main plant, is an auxiliary finishing department for the main plant. Here are located some annealing and pickling equipment, slitters and temper mills for finishing narrow strip draw benches for cold drawing bars, and facilities for the fabrication of Stran-Steel structural members. This plant and another at Terre Haute, Indiana, produce the Quonset buildings which became so prominent during World War II.

The annealing department of Michigan Steel Division consists of 34 in-and-out furnaces and 27 portable cover furnaces. These furnaces are variously fired with natural gas and fuel oil. Fuel consumption here averages 2,500,000 Btu per ton.

Michigan Steel Division, housing pickling and annealing equipment, slitters, temper mills, bar draw benches, etc., is an auxiliary finishing department for the main plant.



Four gas machines, with a total capacity of 54,000 cu ft per hr, provide neutral atmosphere gas to protect the stock during the annealing process.

MISCELLANEOUS AND SERVICES

Mill buildings are roomy, with heavy steel frames, covered for the most part with corrugated sheets. Brick walls and insulated roofs are used for motor rooms. Particular attention was given to lighting and ventilation. Adequate crane facilities are available, as evidenced by Table VII. The steel plant contains 160 cranes ranging 2-300 tons in capacity.

The layout of the original steel plant was made with future expansion in mind. Material flow is progressive, with no back-tracking. About 46 miles of standard gage track is installed in a well planned system, although the plant layout is such that a minimum of movement by rail is required.

The blast furnace plant has 16 miles of track and Michigan Steel about 4 miles. All shifting is performed by 28 diesel locomotives ranging 65-125 tons in size.

Foundations for the heavy buildings and equipment were established by driving piles of an average length of 75 ft to bed rock. These piles were cut off below water level and capped with a heavy concrete pad. Later, some concrete cast-in-place piles were used.

All electric power is purchased. The steel plant is supplied from the utility company's substation through ten separate underground lines at 24,000 volts, 60 cycles. Each line is connected to a 10,000-kva, 24,000/6900 volt, three-phase transformer.

Three of these transformers are connected to No. 1 substation, which serves the 40 in. blooming mill, the 34 in. strip mill and the billet mill and also feeds out to No. 2 substation at the 14 in. merchant mill, No. 3 at the 10 in. merchant mill, No. 9 at the 36 in. pickler, and a unit substation at the gas mixing station.

Three other transformers are tied in to No. 4 substation at the 96 in. strip mill, which also supplies No. 7 station at the 46 in. blooming mill, No. 8 station at No. 2 open hearth, No. 10 station at the cold mills, and No. 12 station at the 96 in. mill coilers.

Two transformers serve No. 5 substation at the cold mills, and also feed to No. 10 station in the cold mill and to No. 14 station supplying coil anneal furnaces and No. 2 bessemer plant.

The other two transformers serve a primary station which feeds No. 11 station at No. 1 bessemer and No. 13 station at No. 3 slabbing mill.

Each transformer is connected to an individual bus section and the bus sections in each station are tied together through a synchronizing bus and reactors. Oil switches are rated at 15,000 volts, 500,000 kva interrupting capacity.

Tie lines run between the synchronizing buses of No. 1 and No. 4 stations, between No. 4 and No. 5 stations, and between No. 1 and the primary station feeding No. 11 and 13 stations.

All power distribution lines are either underground or through the roof trusses of the buildings.

Auxiliary a-c power is distributed at 440 volts from

TABLE VII

Principal Buildings and Cranes — Steel Plant

Building	Length, ft-in.	Width, ft-in.	Cranes	
			No.	Capacity, tons
No. 1 open hearth				
Stockyard	1200-0	110-0	5	15
Leanto	1540-0	50-0	2	5
Charging floor	1540-0	91-8½	3	125/25
			5*	7½
Pouring bay	1622-0	66-6½	5	300/40
Mold yard	852-6	110-3	2	15
Stripper building	200-0	54-2	1	200
			1	400
No. 2 open hearth				
Stockyard	600-0	110-0	2	15
Leanto	715-0	50-0	—	—
Charging bay	880-0	92-0	1	125/25
			1	15
			2*	7½
Pouring bay	770-0	68-0	3	300/40
Mold yard	577-6	110-6	2	25
Stripper building	200-0	60-6	1	200
Skullcracker	400-0	80-0	2	50/15
No. 1 Soaking Pits	900	87-0	2	7½/5
			2	15/5
No. 1 blooming billet and hot strip mills	725	95-0	1	20/5
			1	50/10
No. 1 Slab Yard	650	109-0	3	25
No.1 motor room	650	44-0	1	50
Billet storage	475	109-0	2	15
No. 1 hot strip finishing	500	74-0	1	15
			1	10
No. 1 coil storage and pickling	1450	104-0	4	15
36 in. pickler building	675	26-0	1	10
No. 1 merchant mill	1100	114-0	1	15
			2	10
No. 2 motor room	333-7½	16-0	—	—
No. 1 merchant warehouse	450-0	100-0	1	10
No. 2 merchant mill	1100	109-0	2	10
No. 3 motor room	179-0	36-0	—	—
No. 2 merchant warehouse	1075-0	74-0	2	10
No. 2 blooming and hot strip mills	2152-6	100-0	3	75/25
			2	25
			1	15
No. 2 slab yard	977-6	100-0	6	25
No. 3 slab yard	489-0	100-0	1	25
			1	15
No. 4 motor room	525-0	60-0	1	50
No. 7 motor room	167-6	60-0	—	—
No. 2 hot strip finishing	1500-0	100-0	3	25
No. 2 coil storage and pickling	1225-0	100-0	3	15
Cold roll and annealing — A	1920-0	100-0	2	75
			1	50/10
			3	25
Finishing building — B	545-0	60-0	2	25
Finishing building — C	1025-0	100-0	4	15
Annealing building — D	895-0	100-0	2	75/25
			1	25
Finishing building — E	1495-0	100-0	3	75/25
			2	25
Finishing building — F	1275-0	100-0	1	50/10
			3	25
Shipping building — G	700-0	100-0	1	25
			2	15
Cold roll building — B-1	950-0	60-0	3	25
No. 10 motor room	200-0	36-6	1	25
No. 3 stripper building	228-0	109-0	1	400
No. 2 soaking pits	456-0	109-0	2	25/35
No. 3 slabbing mill	625-0	106-0	1	100/25
			1	25
No. 13 motor room	225-0	106-0	1	100
No. 4 slab yard	750-0	106-0	2	75/25
No. 1 maintenance shop	500-0	52-0	1	25/5
			1	5
No. 2 maintenance shop	500-0	70-0	1	25/10
			2	10

*Floor type charging machines.

These machines at Michigan Steel Division are bowing corrugated sheets into shape for use in Quonset buildings.

all of the principal substations, where 6900/440 volt transformers are installed. These banks range from 500 to 3000 kva in size and represent a combined capacity of about 34,000 kva.

The various load centers also contain conversion facilities for auxiliary 250-volt direct current. These units, which have a total capacity of 14,000 kw, are either motor-generator sets or rectifiers, with the latter prevailing in the more recent installations.

At the blast furnace plant, power is received from the utility company at 4800 volts over seven lines. Three lines go to No. 1 blower house, two to the gas mixer building, one to No. 2 blower house and one to No. 2 coal mixer building. Except for the gas mixer building, each of these stations contain transformers for 440-volt a-c power, totaling 8750 kva capacity, and conversion equipment for 250-volt d-c power totaling 6550 kw capacity. There is also 3900 kva capacity in outlying 4600/440 volt transformers around the blast furnace and coke plants.

The steel plant uses steam for pickling, for heating and pumping fuel oil, and for miscellaneous heating. All of this steam is generated at 150 psi pressure by the 17 waste heat boilers on the open hearth furnaces. All of these boilers are 6000 sq ft units except one, which is 9200 sq ft. The steam is distributed through a loop system of steam lines totaling some 10 miles and varying from 3 in. to 12 in. in diameter. Two oil-fired and three combination oil and gas-fired standby boilers have been provided for emergency use.

At the furnace plant, steam is produced in two boiler houses. No. 1 boiler house, which serves the original coke plant and furnaces, contains six 75,000 lb per hr boilers, all of which burn blast furnace gas and coke oven gas. Two of these units are also equipped with chain grate stokers for burning coke breeze.

All of the boilers operate at 425 psi pressure, 700 F total temperature. Each boiler is equipped with combustion control, forced and induced draft fans, and is connected to its individual stack.

Two of the boilers have economizers, while all of them have superheaters, water walls and air preheaters.

No. 2 boiler house, which serves the new units, contains five 100,000 lb per hr, 425 psi, 700 F total temperature boilers. Each unit contains 16,100 sq ft of heating surface, 2820 sq ft of water wall surface and 16,950 sq ft of air preheater surface, and has 8200 cu ft of combustion volume.

These boilers are fired with blast furnace gas and coke oven gas through four combination burners on each unit, and all are equipped with combustion controls. Each boiler has forced and induced draft fans and is connected to its own stack.

The steel plant is supplied with service water from a pump house containing eight pumps, four rated at 15,000,000 gal per day, four at 30,000,000 gal per day. Some of these are steam driven. This station pumps about 70,000 gpm. The water is distributed through the plant in a loop system containing 14 miles of pipe ranging 6-48 in. in size. There is also about 9 miles of 2-16 in. pipe distributing city water.

At the blast furnace plant, one pumphouse containing four 18,000,000 gal per day pumps supplies the original section of the plant. Water for the surface condensers on the turbo blowers is drawn from these pumps and discharged back into the service water system. When D furnace and the new coke plant were built, another pump house was added, containing four 500,000 gal per day pumps for service water and two 1,600,000 gal per day pumps for condenser water.

All of the service water is drawn through traveling screen intakes from the Detroit River. Chlorination is carried on at all intakes to prevent algae growth in the systems.

Water for boiler feed purposes is treated by the lime-soda process, with a phosphate after-treatment.

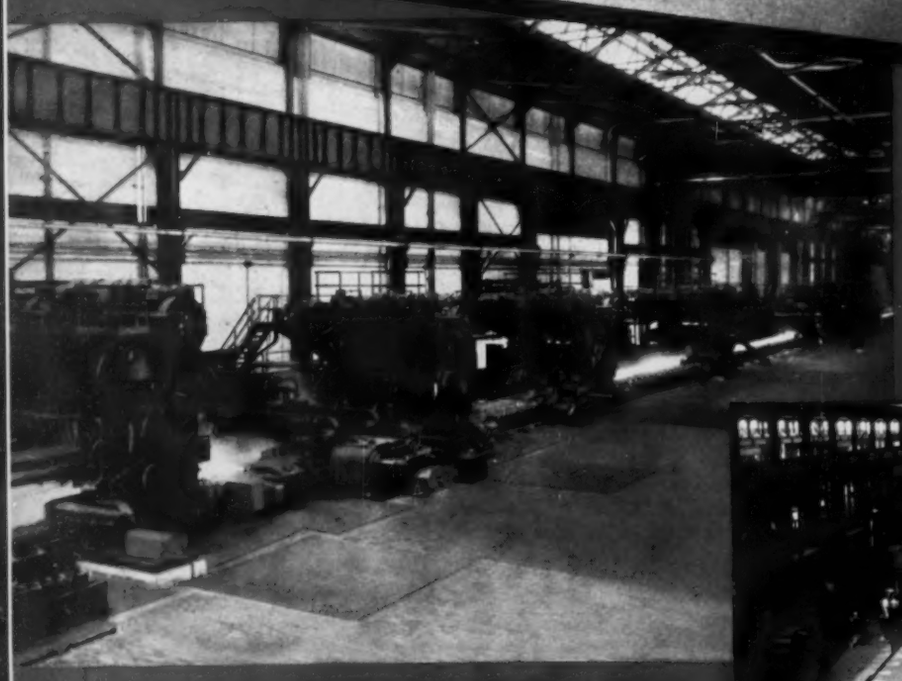
The steel plant is served by approximately 25 miles of sewers running 8-84 in. in diameter.

Most of the principal service shops at the steel plant are centered at the north end of the property, where there are machine, welding, forge, boiler, rigger, locomotive, electric and paint shops, all well equipped to take care of general maintenance work.

Well equipped laboratories are located at essential production centers throughout the plants to check on chemical and physical characteristics and quality of raw materials and products.

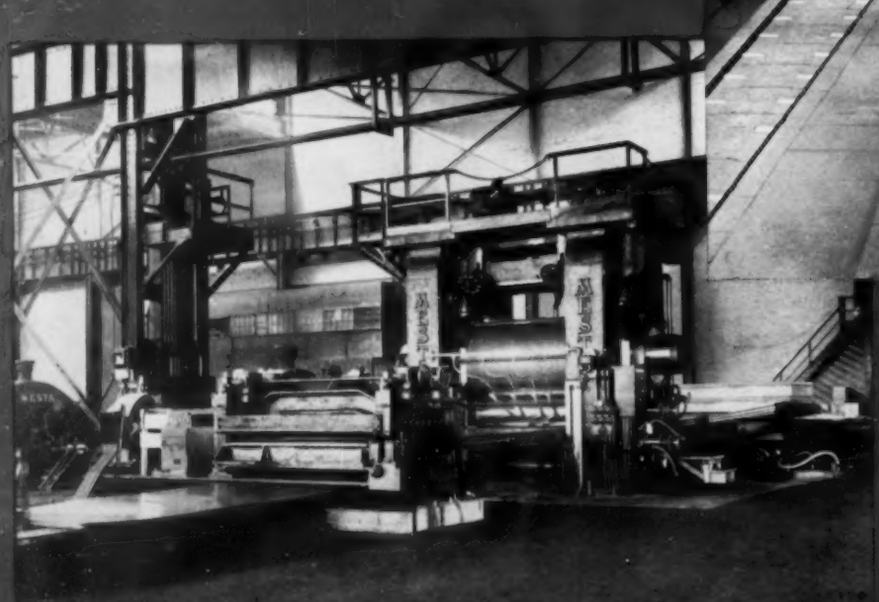
Laboratories at various production centers keep constant check on the chemical and physical characteristics and quality of raw materials and products.

Designed and Built by MESTA



▲ 96" Four-High Continuous Hot Strip Mill

▲ 21"–18"–14"–10" Merchant Mills, with Pack Annealing Cooling Bed and Equipment



◀ 93" Four-High Single Stand Skin Pass Mill with Sheet Charger and Leveller for Rolling Sheets

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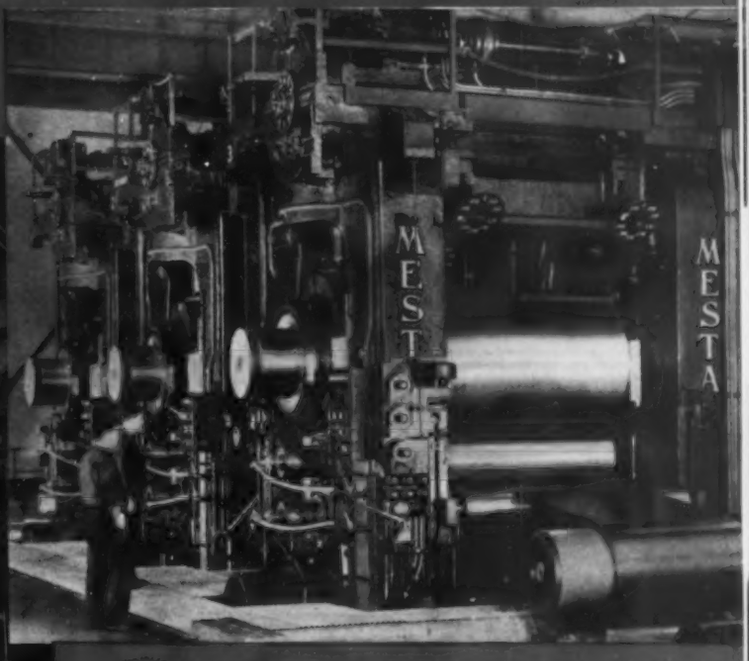
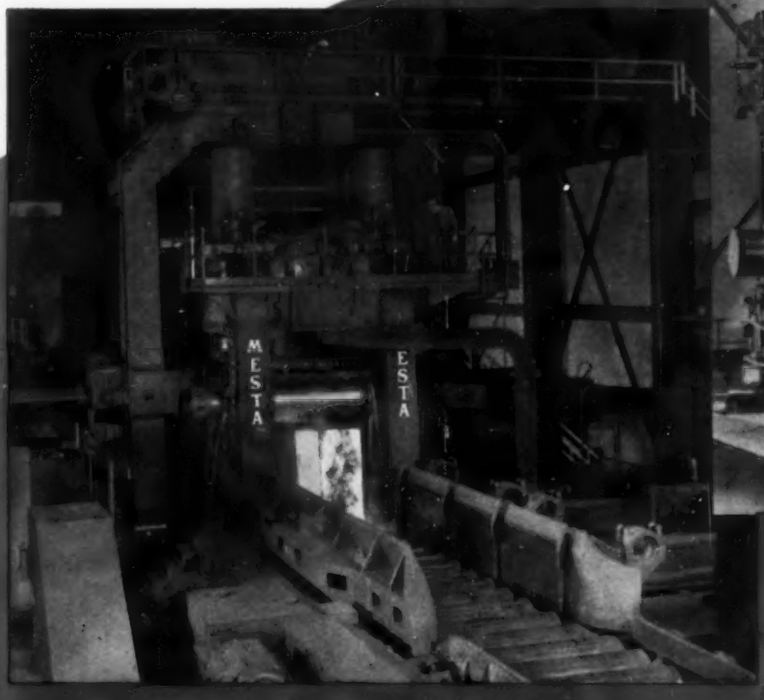
for GREAT LAKES STEEL CORPORATION

DIVISION OF NATIONAL STEEL CORPORATION

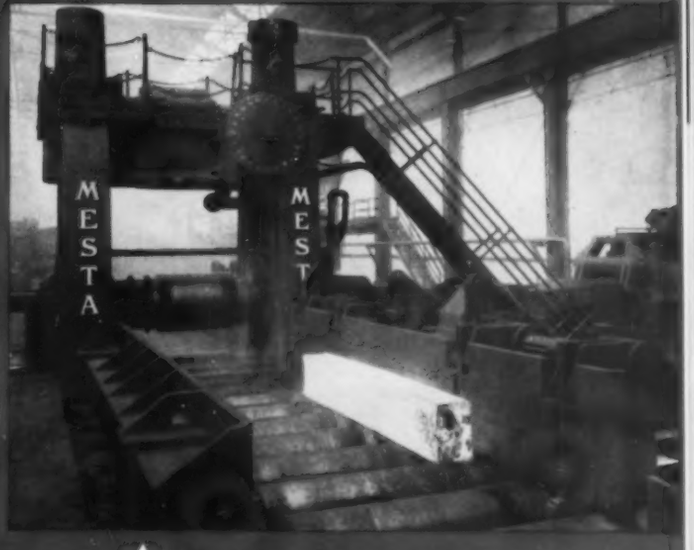
▲ 96" Continuous Pickling Lines with Flash Welders, Trimmers and Up-Coilers



▲ 93" Four-High Three-Stand Tandem Cold Mill for Rolling Wide Strip Steel



▲ 45" x 90" Universal Reversing Slabbing Mill



▲ 40" Reversing Blooming Mill with Manipulators and Tables

◀ 38" Four-High Continuous Hot Strip Mill

MESTA MACHINE COMPANY · Pittsburgh, Pa.

New slabbing mill gains 50% in roll neck strength

with TIMKEN® Balanced Proportion Bearings

THIS 2-high blooming mill, built by United Engineering and Foundry Company, is part of Pittsburgh Steel's $65 million "Program of Progress". To help make sure steel is rolled at the lowest possible cost-per-ton, Timken® balanced proportion bearings are used on the roll necks.

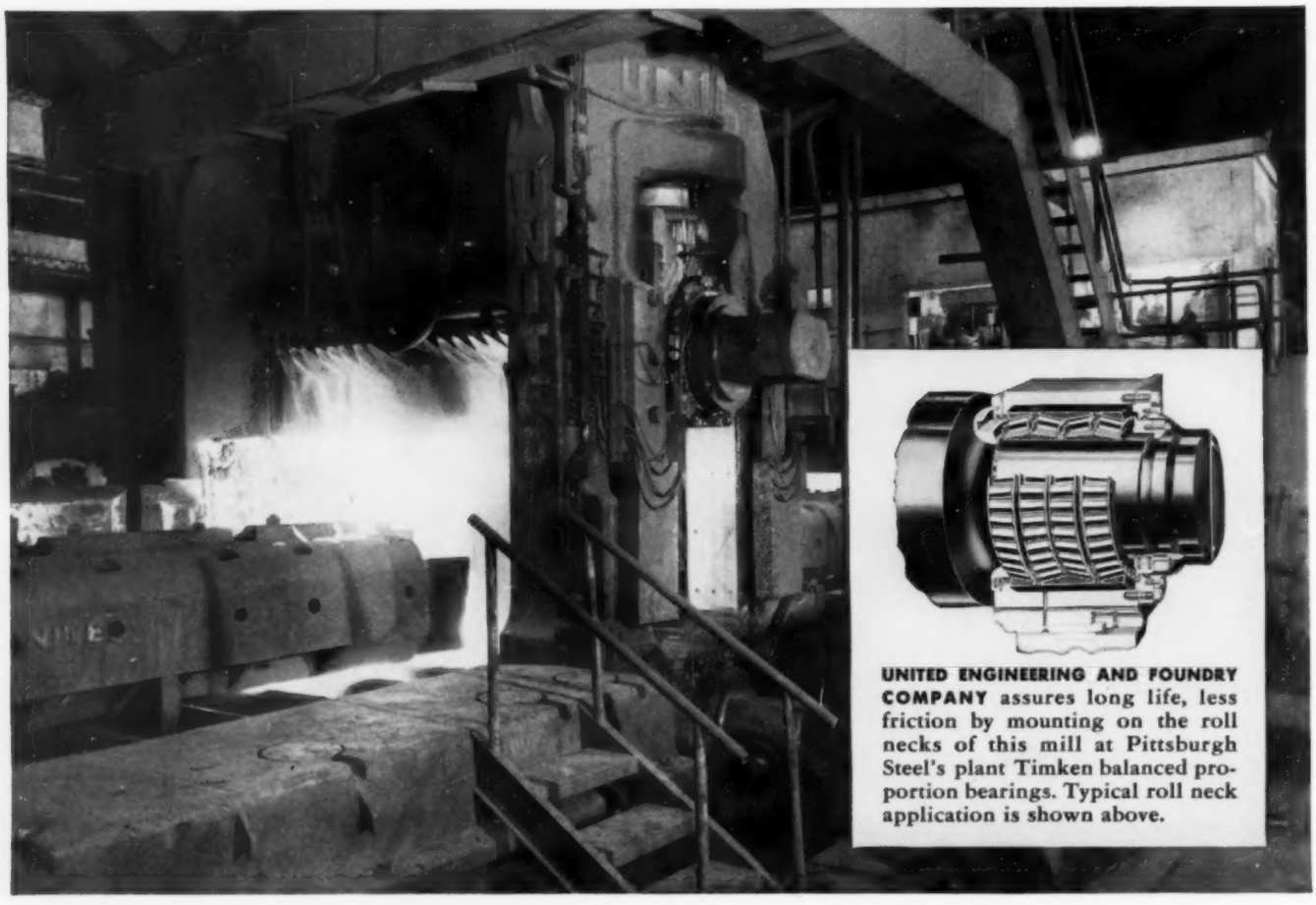
The balanced proportion design of Timken bearings provides a maximum amount of capacity in a given space. Larger diameter roll necks are made possible with no increase in bearing O.D. Load ratings are increased up to 40%, roll neck strength 50 to 60%!

Timken bearings eliminate complicated lubrication systems, permit the use of simple and economical grease lubrication. Rolls can be changed quickly and easily. No special thrust bearings are needed because Timken bearings take both radial and thrust loads in any combination.

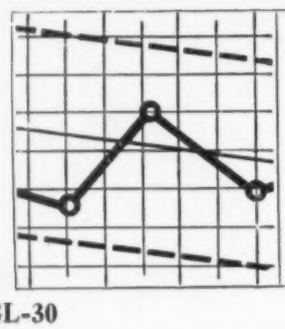
Higher rolling speeds are possible with Timken bearings because they operate freely, practically without friction. Wear is kept to a minimum, long life is assured. Timken bearings are designed to roll true and precision manufactured to live up to their design. We even make our own steel to *insure* quality control. We're the only U. S. bearing manufacturer that does.

Next time, be sure to specify Timken balanced proportion roll neck bearings. For full details, consult our roll neck specialists. Write The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



UNITED ENGINEERING AND FOUNDRY COMPANY assures long life, less friction by mounting on the roll necks of this mill at Pittsburgh Steel's plant Timken balanced proportion bearings. Typical roll neck application is shown above.



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TAPERED ROLLER BEARINGS

Traveling stacker is equipped with tail boom conveyor which can be lowered to receive coal from tripper of either of two belt conveyors in trench.

18 YEARS

of efficient service to Great Lakes Steel

LINK-BELT provides low cost coal handling for Detroit Division of National Steel Corporation

This flexible system receives coal from self-unloading lake vessels, delivers it to storage piles on either side of belt conveyor, and in reclaiming carries it from crane dump hopper, fed by Link-Belt Speeder cranes, to coke plant storage bins. Another outstanding example of Link-Belt's time proven "total engineering".

Whether you're moving coals or coils . . . limestone or iron ore . . . scrap or sinter—this same one-source service can cut your materials handling and power transmitting costs. Our engineers will also work with your own engineers, consultants and builders of mill and process equipment. For full information, contact the Link-Belt office nearest you.

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LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

Coal is fed to belt conveyor system from 7000-ton surge bin at dock front by this feeding car.

Link-Belt self-propelled dump hopper equipped with feeder and loading chute receives coal reclaimed from storage by Link-Belt Speeder cranes and delivers it to belt conveyor.

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produces low volatile Pocahontas Coal that is perfect for making coke for furnace and foundry use. Over 2,000,000 tons each year are refined in this new plant where quality is rigidly controlled, shipping a uniform product. Itmann is a reliable and uniform Pocahontas No. 3 seam metallurgical coal. Low in ash, moisture and sulphur and with the correct expansion. It is dried and cleaned in the world's largest air cleaning plant.

NEW ITMANN PLANT
over 2,000,000 tons annually

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are medium volatile Pocahontas coals, approximately 21% to 23% volatile. They make a splendid coke and will replace both low and medium volatile coals or all low and part of high volatile, requiring only a mixture of 2 coals.

VERY LOW IN ASH — .55 sulphur — unusually low expansion.

These new multi-million dollar preparation plants have just been completed. Here, coal is washed, dried, and uniformly sized. Annual production of 5,000,000 tons of Amonate and Bishop metallurgical coals.

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ROLLWAY bearings for the tough jobs at GREAT LAKES STEEL

▲ Furnace charging tables and furnace delivery tables in the hot strip mill at Great Lakes Steel. Rollway MUC bearings with separable inner races are fitted on roller ends.

Crane hook in the hot strip mill. The Rollway Thrust Bearing on the hook spindle supports the entire load of slabs, and has proved its low-cost service in comparison with other crane hook bearing installations. ▶

RADIAL TYPE MUC
Separable Inner Race

THRUST TYPE T
Single-Acting

Rollways Roll Right because they're Made Right

- Bearing surfaces are ground precisely parallel to insure unwavering right-line rolling.
- Separator slots are precisely machined to prevent roller skew, slide and uneven wear.
- Rollway's Right Angle Design gives you Right Angle Trueness.

Preference for Rollway MUC Bearings in the illustrated installations at the Great Lakes Steel Division of National Steel Corporation is based on the need for longer bearing life under rigorous strain. Rollway's axial float prevents damage from end-wise expansion of table rollers due to heat, and thereby prevents high friction and undue wear within the bearings.

Rollway Thrust Bearings replaced bronze bearings previously used in Great Lakes Steel's slab pilers. Heat and friction coefficients no longer cause bearing failure. Rollway's Thrust Bearings assure longest life and greatest reliability under continuous heavy duty operating conditions.

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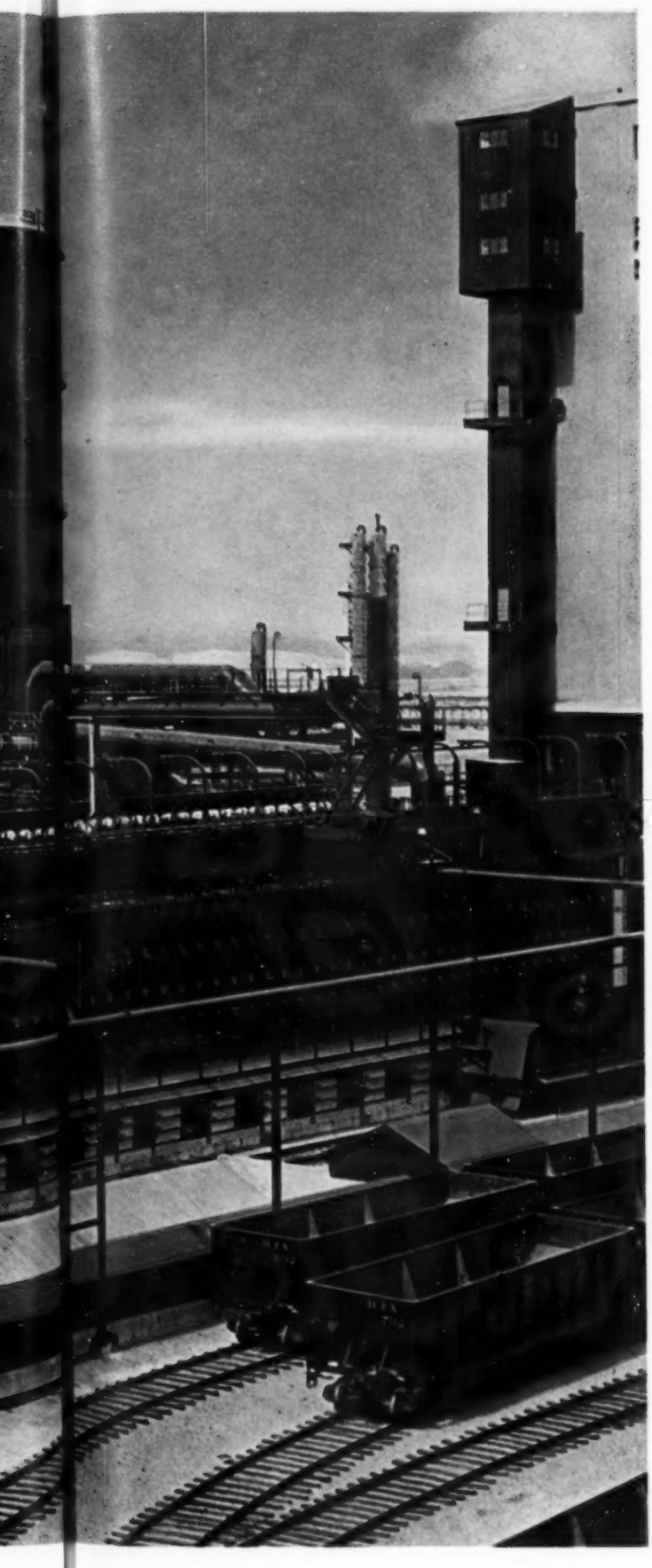

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Division of National Steel Corporation,
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- **double collecting mains**
- **mechanical coal charging cars**
- **ammonium sulphate process for improved crystal product**
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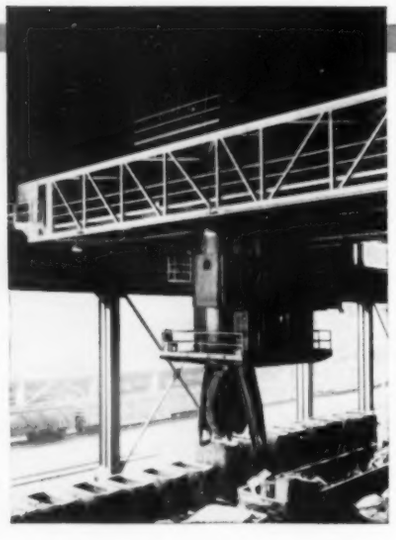
AT GREAT LAKES STEEL...

139 Morgan Cranes on the Job



In Great Lakes Steel's Ecorse works, you'll see 139 Morgan cranes helping to keep production on schedule and maintenance costs down at this important division of National Steel Corporation.

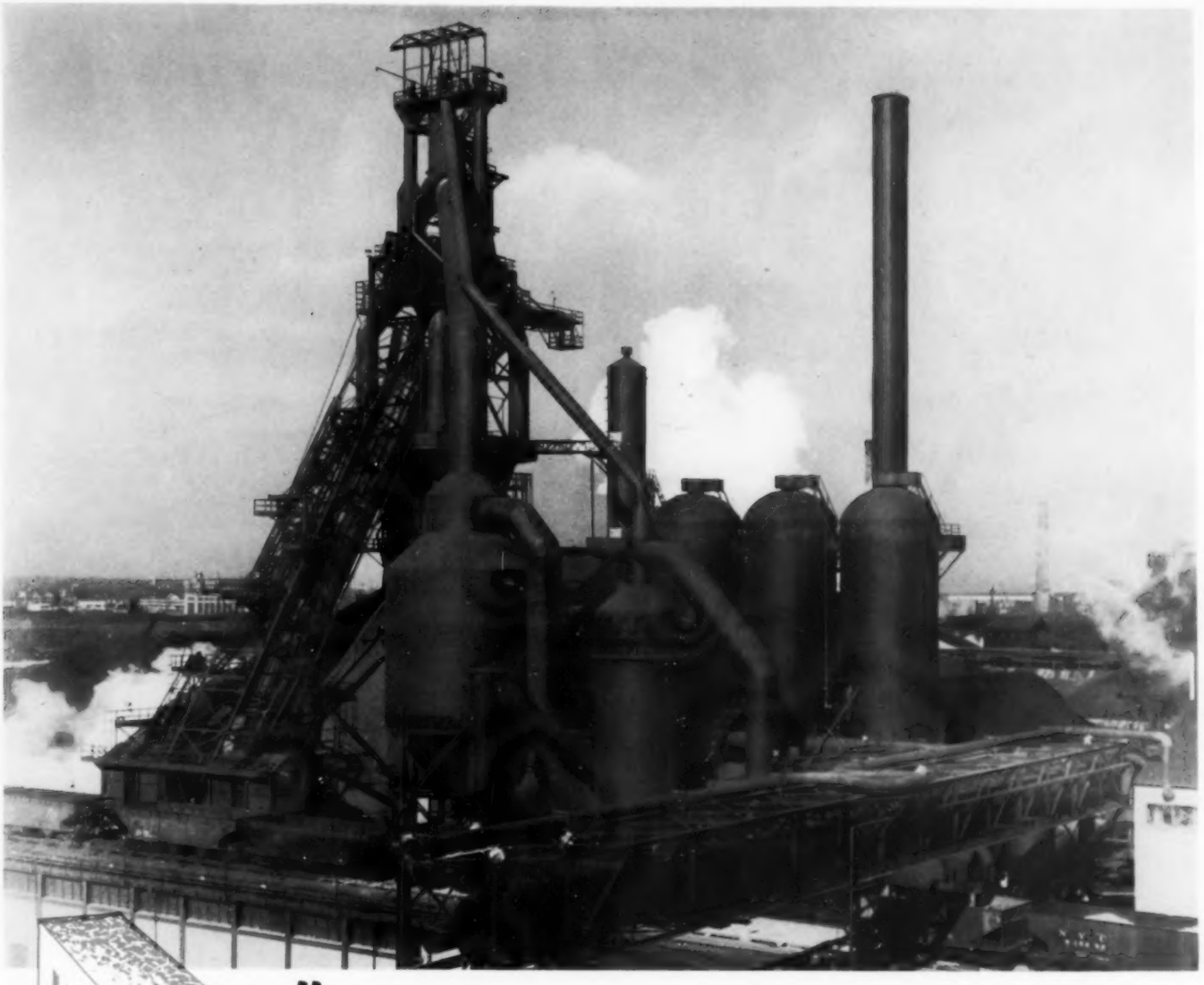
Morgan cranes are built in all sizes and types to handle any job, from giant 350-ton ladle cranes to small soaking-pit models.

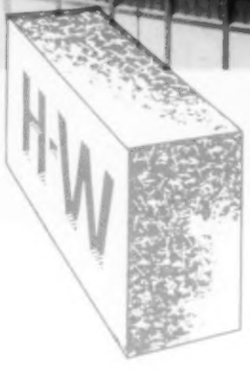
Since 1867, when Morgan pioneered the first overhead crane, we have led in developments and improvements to keep Morgan cranes the best buys in their fields.

Write for literature on Morgan cranes, rolling mills, steelmill machines, and special equipment.

MORGAN ENGINEERING of ALLIANCE, OHIO

MORGAN ENGINEERING COMPANY • ALLIANCE, OHIO





"...refractories are Harbison-Walker"

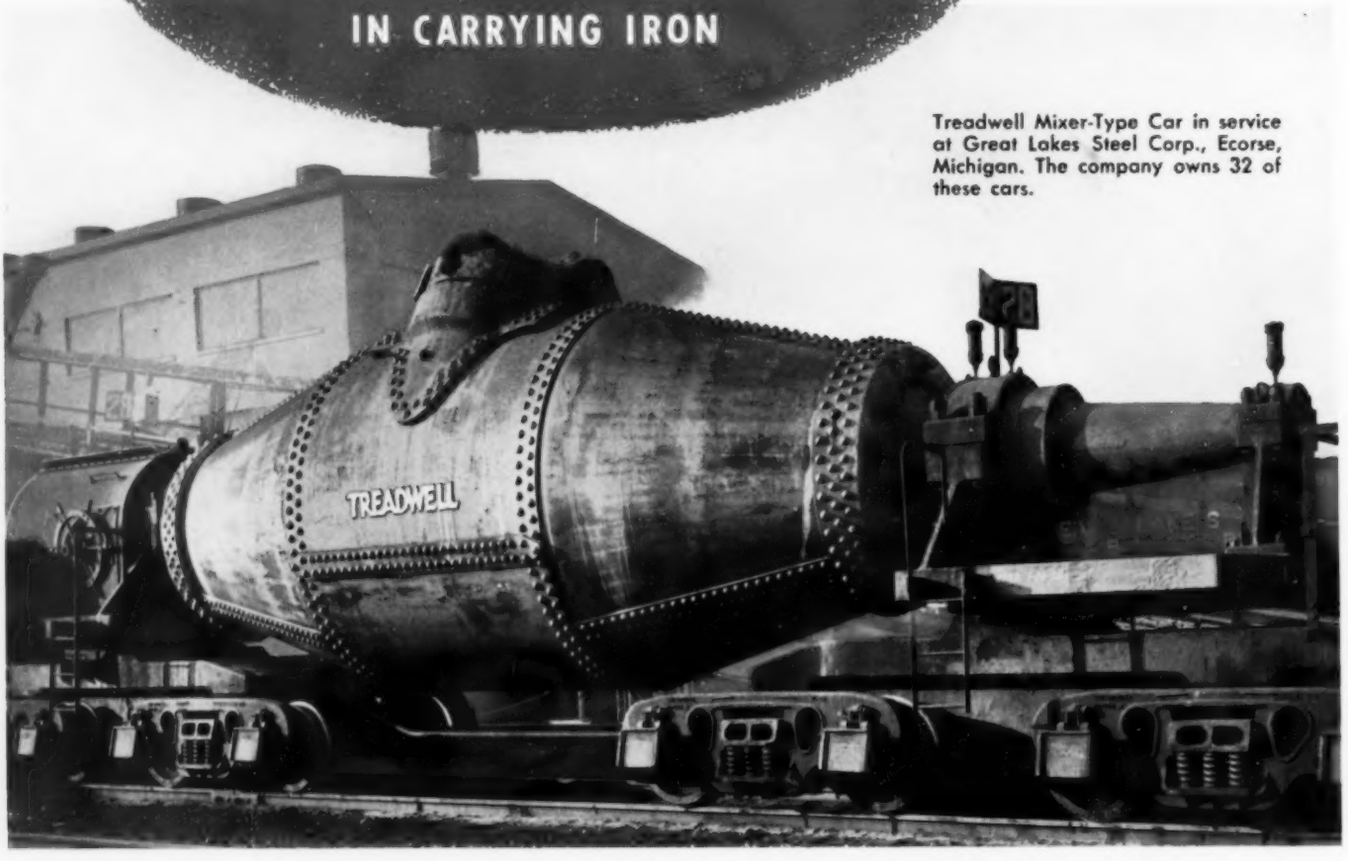
...a familiar phrase at Great Lakes Steel

At Great Lakes Steel, Detroit division of National Steel Corporation, Harbison-Walker is a familiar leading name—as it is in other blast furnace and steel plants. The furnace shown above, its stoves and all its piping are among those at the Zug Island Plant of Great Lakes Steel lined wholly or largely with Harbison-Walker refractories.

Throughout the iron and steel industry, the various types and classes of Harbison-Walker refractories are widely preferred—for blast furnaces, open hearths, electric furnaces, heating furnaces and for the many other diversified needs. And through a continuing product-development program, Harbison-Walker meets the anticipated and ever-changing demands of the industry's rapid progress. It is for this reason and also because of the rigidly controlled high quality of these products that they are favored by experienced operators everywhere.

HARBISON-WALKER REFRACTORIES COMPANY
and Subsidiaries
World's Largest Producer of Refractories
General Offices: Pittsburgh 22, Penna.

HOW GREAT LAKES STEEL *CUTS HEAT LOSSES* IN CARRYING IRON



Treadwell Mixer-Type Car in service at Great Lakes Steel Corp., Ecorse, Michigan. The company owns 32 of these cars.

Great Lakes Steel, Detroit division of National Steel Corporation, is able to cut heat losses by carrying iron in Treadwell Mixer-Type Hot Metal Cars, because these cars retain heat considerably better than open-top cars. This is true of both the iron carried and the lining of the ladle.

While heat loss in the mixer ladle of a Treadwell car may average 10° per hour, the loss in an open-top ladle may be as high as 55° per hour.

Hotter iron means less kish and, as a result, increased tonnage delivered to the steel furnace or pig casting machine. As it's common practice to hold cars at steel furnaces from three to six hours, and since many plants hold them ten to twelve hours, heat loss per hour is an important factor to consider.

Then too, shorter blast furnace runners can be used with mixer-type cars. This results in hotter iron at the ladle—50° hotter is reported by many plants.

But, greater heat retention is only one of the many advantages of Treadwell's exclusive Mixer-Type Hot Metal Car. Send for new bulletin No. 60. It describes these cars in detail.

M. H. TREADWELL COMPANY, INC.

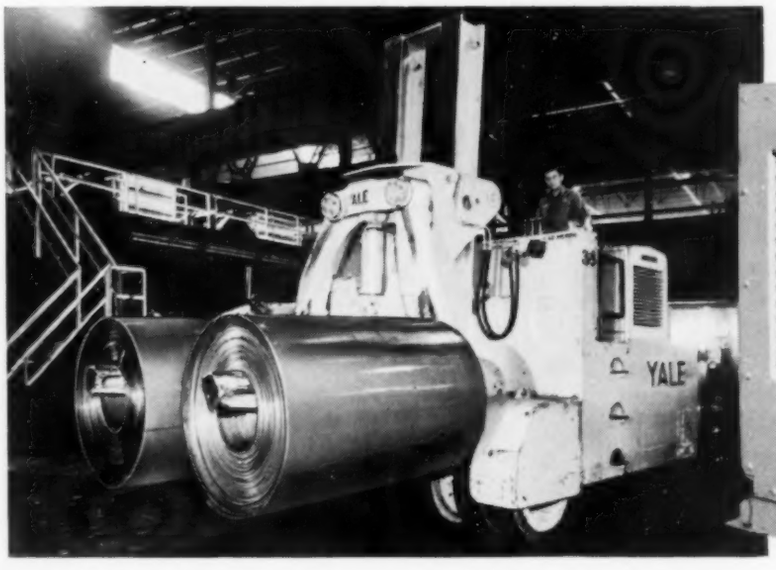
140 Cedar Street, New York 6, N. Y.
1015 Farmers Bank Bldg., Pittsburgh 22, Pa.
208 So. LaSalle St., Chicago 4, Ill.

TREADWELL

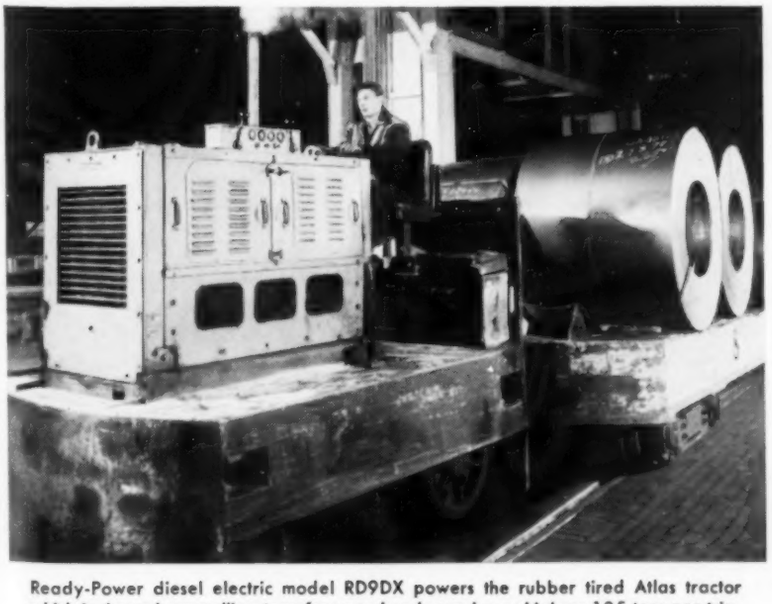
Mixer-type
HOT METAL CARS

TR-13

Automatic single ram truck powered by Ready-Power diesel-electric model RD9DX handles a large coil of steel. Full electric drive makes operation extremely simple.



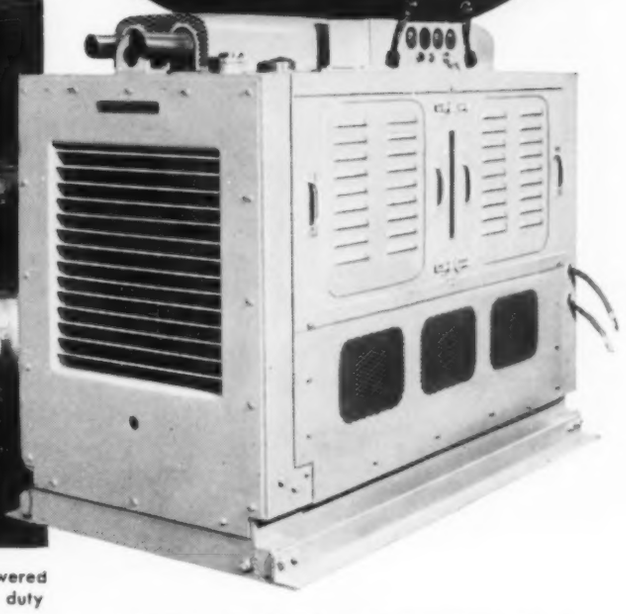
This 80,000 lb. capacity Yale split ram truck moves two 30,000 lb. coils of steel. Powered by Ready-Power diesel electric model RD18DX, the truck is on 20-turn per week duty



Ready-Power diesel electric model RD9DX powers the rubber tired Atlas tractor which is shown here pulling transfer cars. Loads can be as high as 125 tons per trip.

on the job
ALL the time
at Great Lakes
Steel Corporation

READY-POWER
DIESEL ELECTRIC
POWER



Schedules at The Great Lakes Steel Corporation, Detroit Division of National Steel Corporation call for materials handling trucks that operate at top efficiency *all the time*. And experience has shown that trucks equipped with Ready-Power diesel-electric meet performance requirements at economical costs per ton-mile.

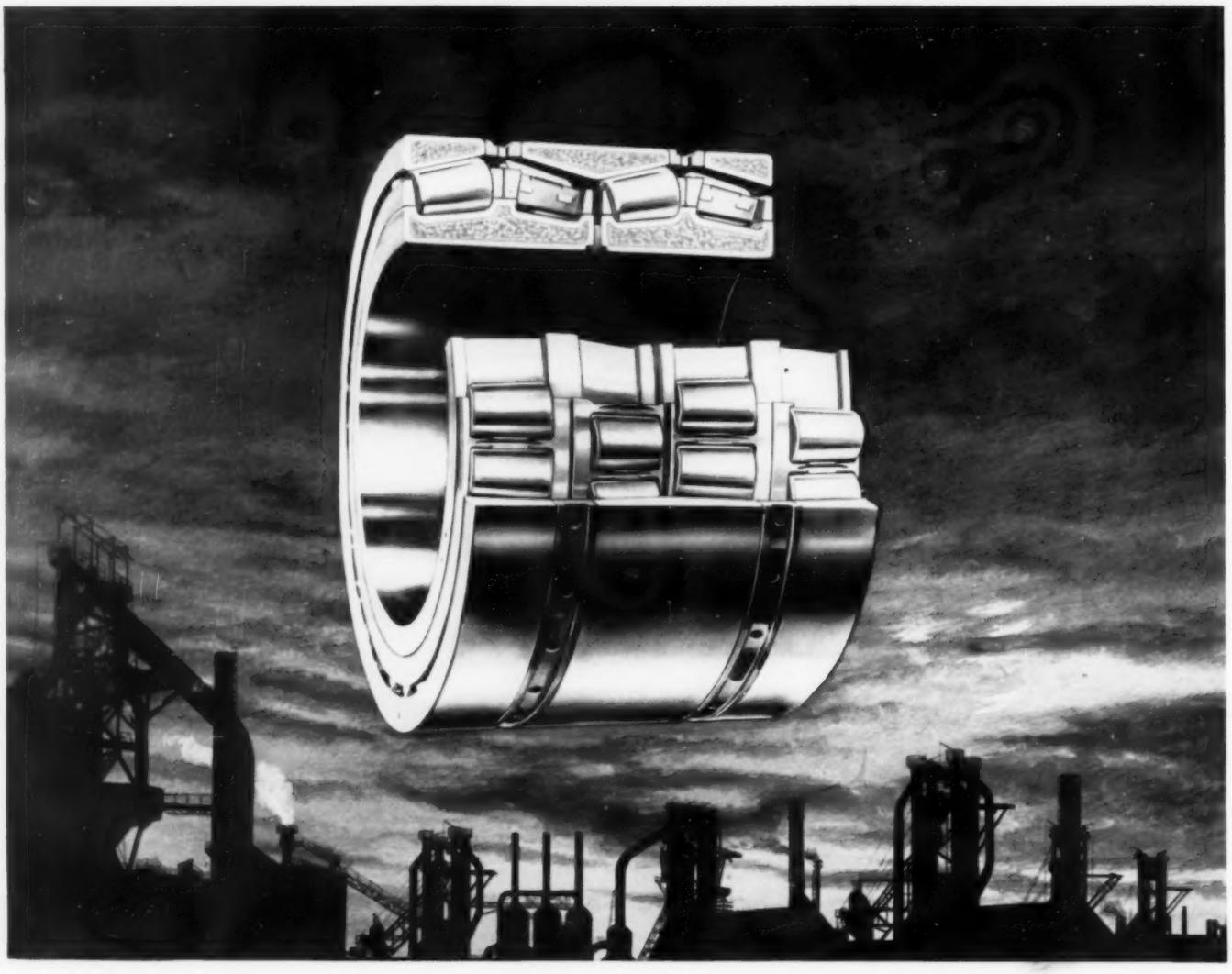
A user of Ready-Power gas-electric since 1930, Great Lakes was one of the first to put Ready-Power diesel-electric into service when it was introduced in 1950. Many units have been added since then.

Why not put this full-time power to work in your mill? Write for information.

READY-POWER

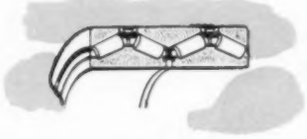
The READY-POWER Co., 3818 GRAND RIVER AVE., DETROIT 8, MICH.

Manufacturers of Gas and Diesel Engine-Driven Generators and Air Conditioning Units; Gas and Diesel-Electric Power Units for Industrial Trucks

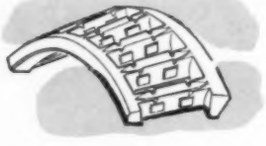


Here's why **TORRINGTON** work roll bearings establish rolling mill records

Highest quality electric furnace alloy steels are used—carburized and heat treated to provide toughness, hardness, stability and uniformity.



Torrington Work Roll Bearings are designed and built with high thrust capacity to give better service under actual operating conditions.



One-piece cast-bronze cages with machined pads in each roller pocket reduce wear, lengthen bearing life and improve performance.

Accuracy in workmanship is characteristic of all TORRINGTON Bearings. This means a lower cost per ton of your finished product.

Many sizes of TORRINGTON WORK ROLL Bearings are available from stock for immediate shipment.

TORRINGTON WORK ROLL Bearings—both two-row and four-row types—are standard in a wide variety of sizes.

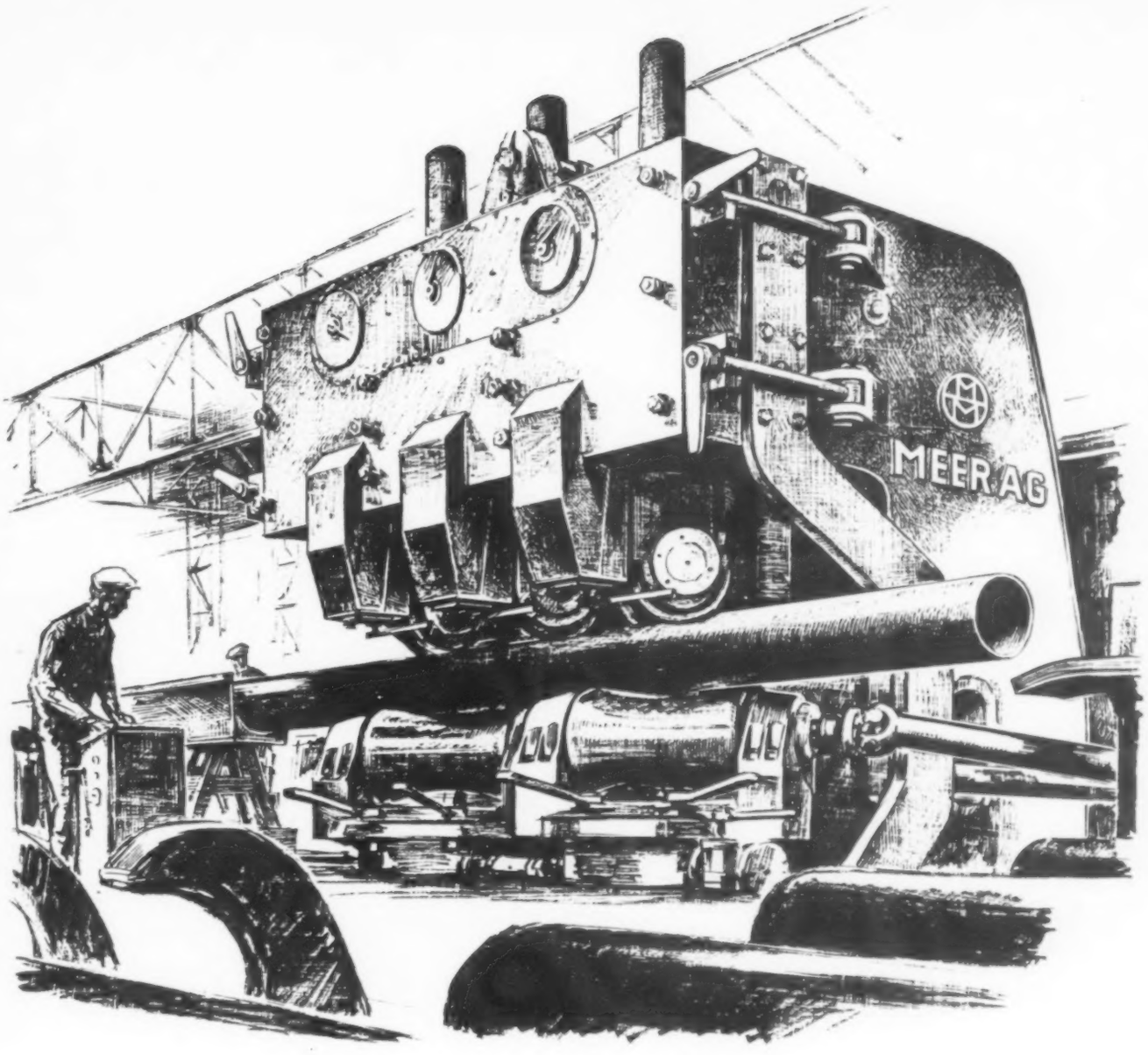
For lower operating costs, greater rolling efficiency, less down time...specify TORRINGTON!

THE TORRINGTON COMPANY

South Bend 21, Ind. • Torrington, Conn.

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers



New Straightener Line Speeds Mill Production

Mannesmann-Meer's new line of vertical skewed roll rotary straighteners handles a wide range of tubing and bar stock sizes in one single pass at high production speeds. Special hyperbolic shape of straightener rolls provides for extra length of contact between roll surface and work piece, improves the surface quality and prevents yield marks which ordinarily result when stressing material through the elastic limit. Even thin-walled tubing made of non-ferrous metals and liable to easy fracture are straightened with best result. The close roll spacing made possible by this new design combined with heavy anti-friction roll bearings accomplishes the best possible straightening effect, even on high strength steel tubes and bars. This new straightener incorporates the most advanced design yet developed and comes as a result of the combination of

- CREATIVE ENGINEERING
- DESIGN EXPERIENCE
- OPERATING BACKGROUND
- AMERICAN MANUFACTURING SKILL

which is available only from Mannesmann-Meer. Put us to work today on your straightening problems.

MANNESMANN-MEER

ENGINEERING AND CONSTRUCTION COMPANY, 900 LINE STREET, EASTON, PENNA

WORLD SPECIALISTS IN HIGH-SPEED TUBE MILL MACHINERY

NEWEST ORE BRIDGES AT ZUG ISLAND ARE WELLMANS

Three Wellman 15-gross-ton ore bridges unload ore fast at Great Lakes Steel Corporation, Zug Island, Michigan. These are man trolley bridges with portal pier legs, and a 264-foot span. Buckets rotate 90 degrees to simplify digging and clean-up.

This is another example of speedy bulk materials handling that pays off for users of equipment designed and manufactured by Wellman.

WELLMAN EQUIPMENT AT GREAT LAKES STEEL CORPORATION
Division of
National Steel Corporation

- 3 Wellman 15-gross-ton Ore Bridges
- Wellman Skip Hoist
- Wellman Coke Pushers
- Wellman Coke Quenching Cars
- Williams Buckets

THE WELLMAN ENGINEERING COMPANY
7000 CENTRAL AVENUE • CLEVELAND 4, OHIO

McDOWELL

a McDowell enterprise

Heat treating plate

at Great Lakes Steel Corporation, Detroit, Mich.

This Drever Continuous Furnace line, shown in operation, heat treats plate up to 72" wide x 28'-0" long in thicknesses ranging from 1" down.

Various inter-connected units, including hardening and tempering furnaces, straightening quench, scrubber, kick-off tables and transfer car are operated from centrally located pulpits.

Drever's reputation is based on performance of units such as this, where quality of product, high production rates, and low maintenance costs are key factors. Plates heat treated in this installation emerge flat and require no further straightening.

Production is High and Costs are Low

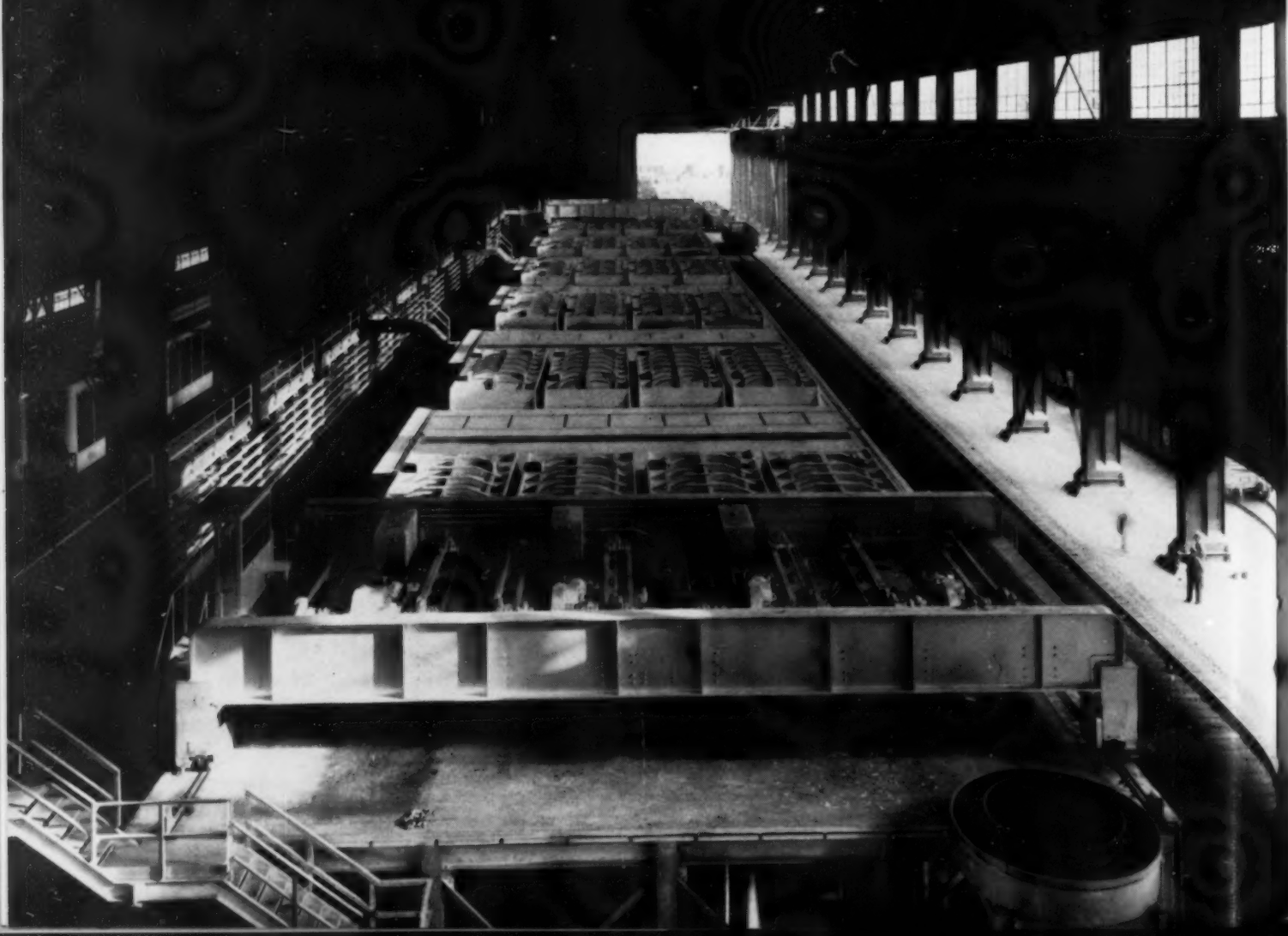
On left—Pressure Quench at Discharge of Hardening Furnace. Also Transfer Car moving Plate to be charged into Tempering Furnace.

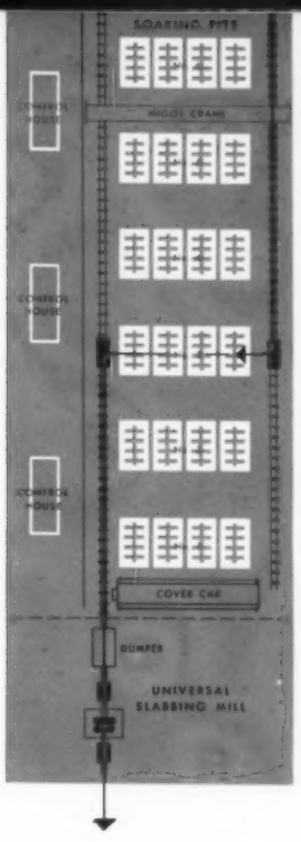
DREVER COMPANY

RED LION ROAD AND PHILMONT AVE. • BETHAYRES, PA.

26

at Great Lakes, too...





high-production soaking pits

. . . a convincing example of 'Surface' leadership. Behind the story of these 24 soaking pits at Great Lakes Steel, Detroit Division of National Steel Corporation, is an imposing record of achievement: Surface Combustion has built 80% of all new pits since World War II.

At Great Lakes, six batteries, four 'Surface' pits in each, heat low carbon steel ingots for automotive and appliance steel. They also heat some low alloy steel ("NAX" grade).

These one-way fired pits include such 'Surface' features as the efficient jet pump recuperative system, and integrated temperature and combustion controls which are of the most modern design. The performance of these pits, and many others, is among the reasons why steelmakers depend on 'Surface.'

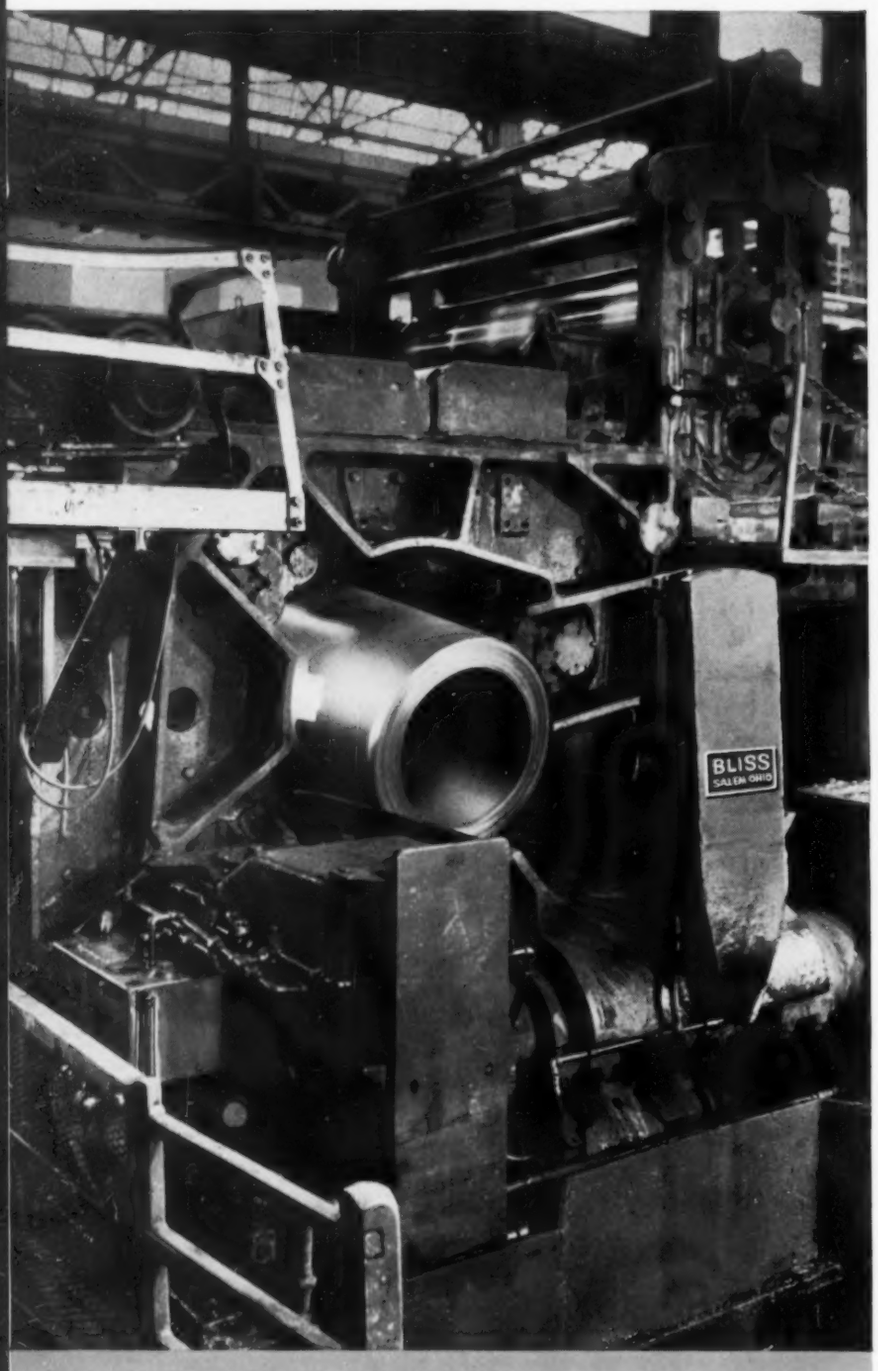
SURFACE COMBUSTION CORPORATION, TOLEDO, OHIO

Surface
STEEL MILL FURNACES

Foreign affiliate companies:

British Furnaces, Ltd., Chesterfield; Stein & Atkinson, Ltd., London
Stein & Roubaix, Paris, Liege, and Genoa; Chugai Ro Kogyo Kaisha, Ltd., Osaka
Benno Schilde Maschinenbau, A.G., Bad Hersfeld (Hessen, Germany)

At Great Lakes Steel, too—



A BLISS HOT MILL DOWNCOILER

This 28" x 96" Bliss hot mill downcoiler at the Great Lakes Steel Corp., Detroit Division of National Steel Corp., is but one of a number of downcoiler installations designed and built by Bliss since it pioneered the development of these expanding mandrel type downcoilers.

Similarly significant installations include Bliss coilers at U. S. Steel Company plants, and others at Ford Motor Company, Youngstown Sheet & Tube Company, Brazilian National Steel Company and August Thyssen Hutte A.G. (Western Germany).

While these coilers vary in size, the expanding mandrel feature, common to all, makes possible high-tension coiling—results in tightly wound, solid, smooth-edged coils. Moreover, the collapsible feature facilitates stripping of finished coils...eliminates surface damage.

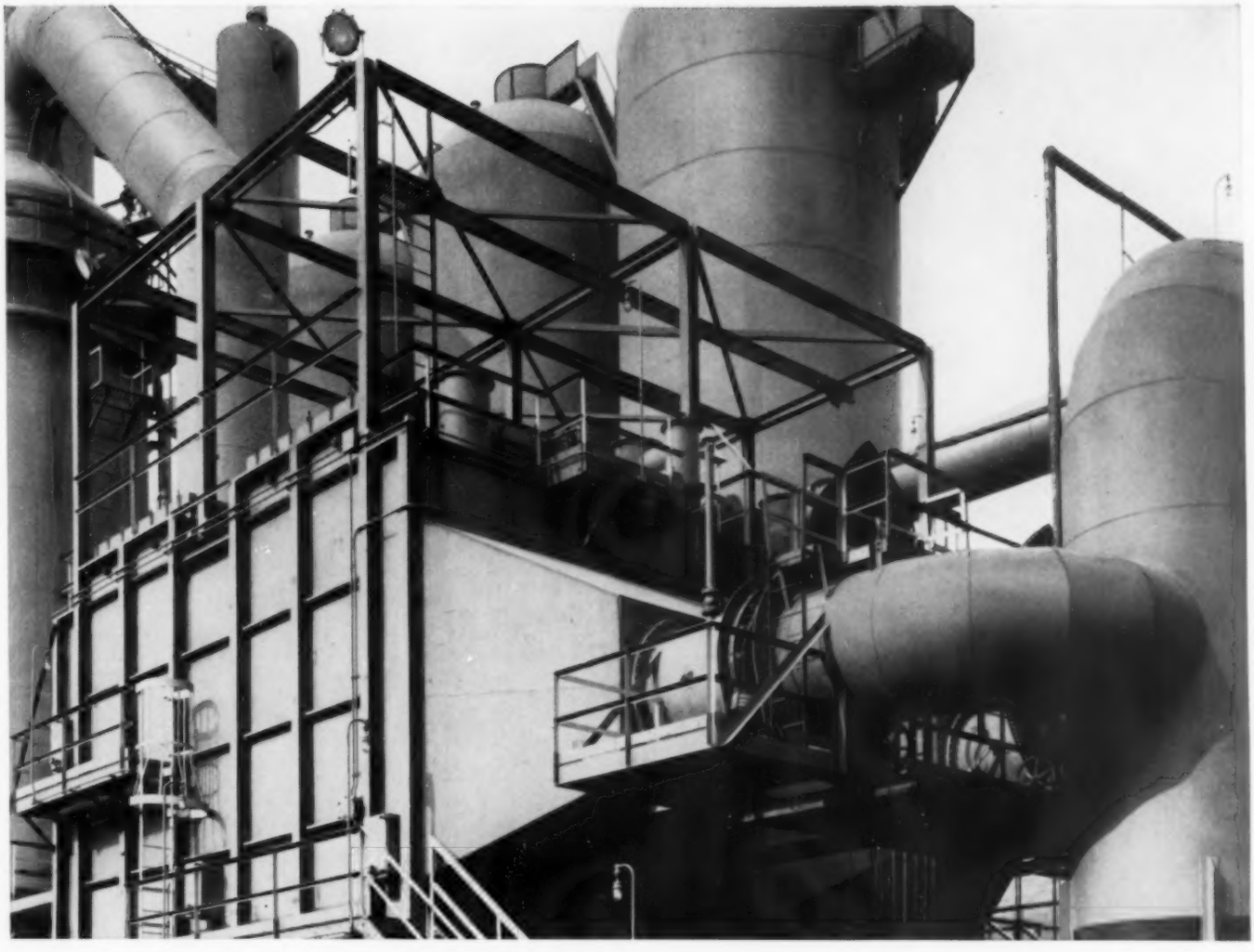
For more complete information on these and other installations, write for a copy of our 60-page Rolling Mill Brochure, Catalog 40-A. It's yours for the asking.

E. W. BLISS COMPANY, General Office: Canton, Ohio
ROLLING MILL DIVISION: Salem, Ohio

BLISS
SINCE 1857

is more than a name...it's a guarantee

PRESSES, ROLLING MILLS, SPECIAL MACHINERY
Plants: Canton, Cleveland, Salem and Toledo, Ohio; Detroit and Hastings, Michigan; San Jose, California



Great Lakes Steel cleans furnace gas with a Koppers Electrostatic Precipitator

At the Zug Island plant of the Great Lakes Steel Division of National Steel Corporation, blast furnace gas is cleaned and used as fuel for coke ovens, steam boilers, stoves and steel mill furnaces. To clean this gas a Koppers Electrostatic Precipitator was installed.

Actual performance data shows the Koppers Precipitator yields much cleaner gas than specifications called for. In 24-hour operation, it cleans 130,000 cu. ft. of gas per minute; precipitates 3,700 lbs. of solids per 24 hours. Maintenance is minor.

Koppers dependability and performance is attested by the fact that Great Lakes Steel has specified a Koppers Electrostatic Precipitator for another new blast furnace.

Great Lakes Steel's satisfaction and confidence is typical of Koppers installations everywhere. Koppers engineering, research and problem analysis experience have found the solution to hundreds of different gas cleaning problems. If you need assistance with such a problem, call on Koppers—mail coupon below.

KOPPERS

ELECTROSTATIC PRECIPITATORS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD. This Koppers Division also supplies industry with Fast's Couplings, American Hammered Industrial Piston and Sealing Rings, Aeromaster Fans, Gas Apparatus.

Engineered **Products Sold with** ***Service***

KOPPERS COMPANY, INC., *Electrostatic Precipitator Dept.,* **214 Scott St., Baltimore 3, Md.**

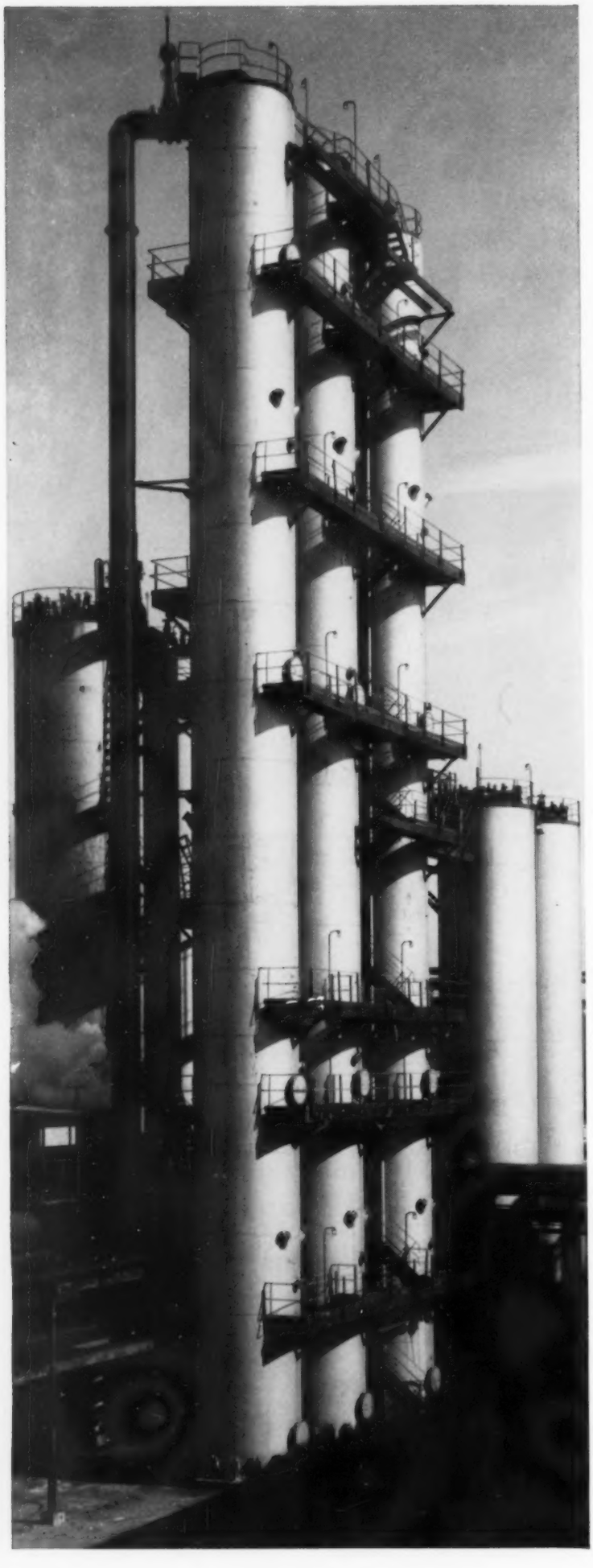
Gentlemen: I am interested in a review of my gas cleaning problem.

Name .....

Company .....

Address .....

City ..... Zone ..... State .....



GRAVER

Gas and Chemical "scrubbers" for Great Lakes Steel

(DIVISION OF NATIONAL STEEL CORPORATION)

At Great Lakes Steel Corporation's Blast Furnace Division, a new by-product coke plant is equipped with a total of 25 large examples of Graver's craftsmanship in steel.

These structures, shop-fabricated at Graver's East Chicago plant and field-erected on the site by Graver crews, were built to the designs of Wilputte Coke Oven Division, Allied Chemical & Dye Corporation. These include bins, stacks, gas coolers, tanks for chemical feed, storage, and settling—and scrubbers such as the three 132′ towers shown at the left.

This variety of quality fabrication indicates Graver's versatile craftsmanship—demonstrates Graver's ability to shop-fabricate and field-erect structures for the steel, petroleum and chemical industries. For process and storage equipment in steels, alloys or clads, Graver's offices across the country are staffed with competent engineers ready to serve you.

GRAVER ... craftsmen in carbon, stainless and alloy steels

GRAVER TANK & MFG. CO., INC.

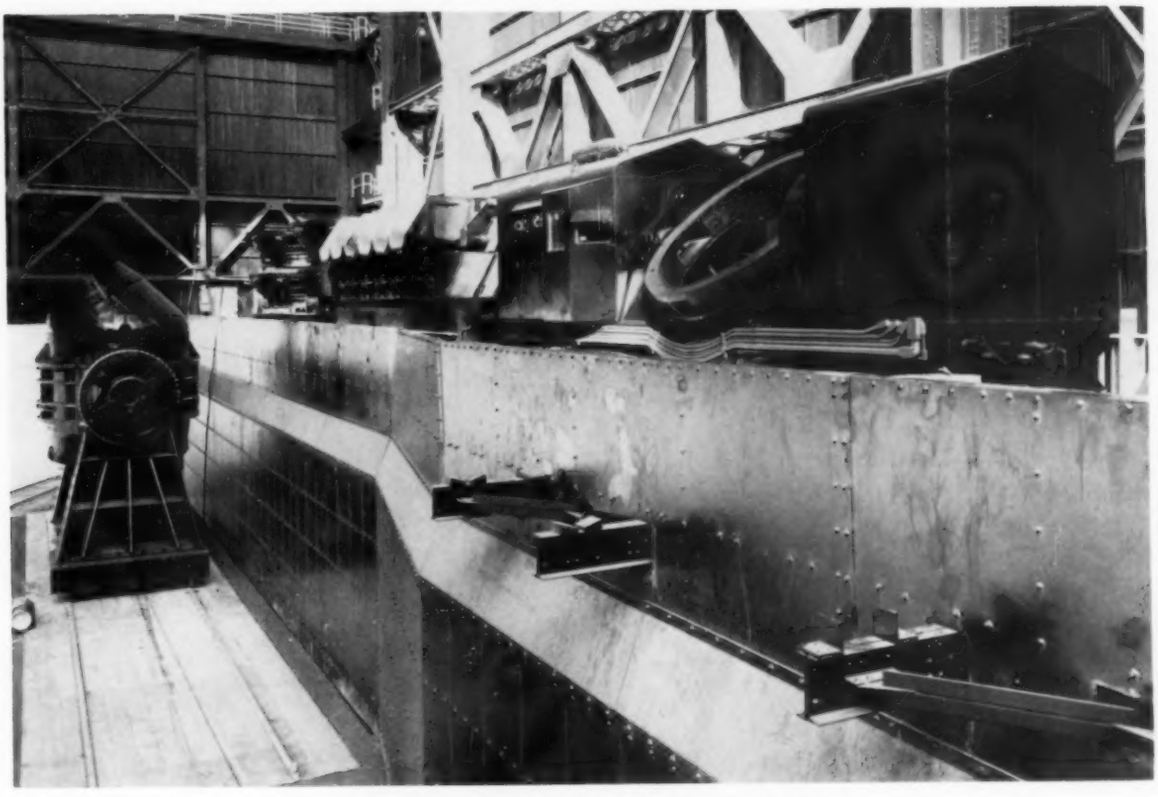
EAST CHICAGO, INDIANA

CHICAGO • NEW YORK • PHILADELPHIA • EDGE MOOR, DEL.
CATSAUQUA, PA. • PITTSBURGH • CLEVELAND • DETROIT
TULSA • SAND SPRINGS, OKLA. • HOUSTON • ODESSA, TEXAS
CASPER, WYO • LOS ANGELES • FONTANA, CAL. • SAN FRANCISCO

PENNSYLVANIA ENGINEERING CORPORATION

NEW CASTLE, PENNA.

Designers, Fabricators and Erectors of
CONVERTERS
For
Bessemer — Duplexing — Hot Scrap — Oxygen
6 to 60 TON CAPACITY



At Great Lakes Steel Corporation
Division of National Steel Corporation
30-TON CONVERTERS
Relining Converter Car, Diesel Hot Metal Transfer Car and 6-Box Scrap Car

INSTALLATION OF CONVERTERS IN THE FOLLOWING STEEL PLANTS

Great Lakes Steel Corp., Div. National Steel Corp.
United States Steel Corp.
National Tube Division, U. S. S.
Tata Iron & Steel Company, India
Jones & Laughlin Steel Corp.
Weirton Steel Company, Div. Nat. Steel
Tennessee Coal & Iron Division, U. S. S.
Bethlehem Steel Company
Algoma Steel Company
Youngstown Sheet & Tube Co.
Republic Steel Corp.
A. M. Byers Company
Copperweld Steel Company
Cia Fundidora de Fierro y Acero de Monterrey, Mexico
Cia Acos Especiais Itabira, Brazil

Scrap Car

AUXILIARY EQUIPMENT FOR BESSEMER CONVERTER PLANTS

Hot Metal Mixers
Tilting Open Hearth Furnaces
Ladles
Ladle Stands
Ladle Transfer Cars
Scrap Cars
Cupolas
Slag Cars
Dragouts
Slag Pots
Jib Cranes
Jack Cars
Bottom Oven Cars
Bottom Ovens
Post Ladle Cranes
Ingot Cars
Scrap Buckets

View of 5 parallel
42" nominal diameter x 18' tube length
ammonia liquor coolers.

NATIONAL Shell and Tube Heat Exchangers installed at Great Lakes Steel Corporation

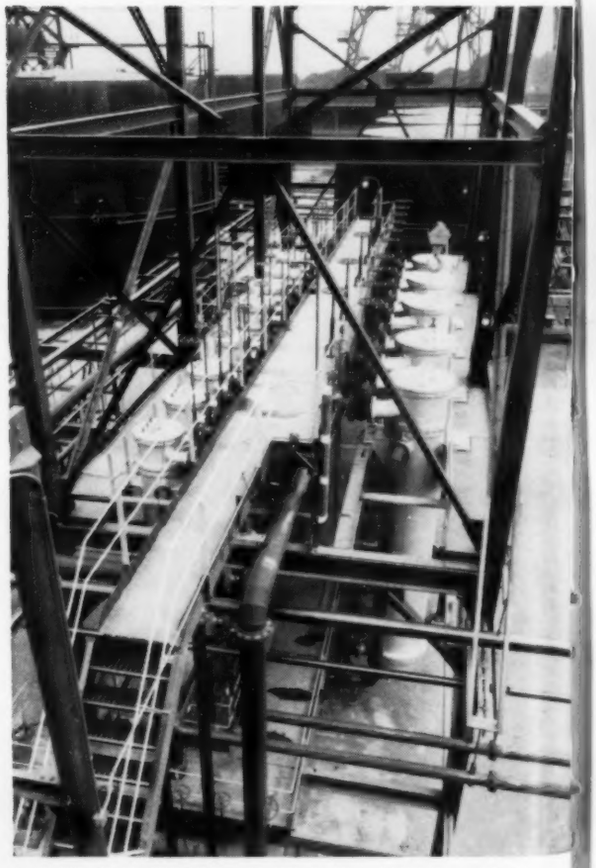
Ecorse, Michigan

THE NATIONAL RADIATOR COMPANY congratulates Great Lakes Steel Corporation, Detroit unit of National Steel Corporation, on their plant expansion, and is proud to have been chosen to design and build its major items of heat transfer apparatus for the blast furnace division at Zug Island.

This integrated engineering and fabricating service is available to all the process industries.

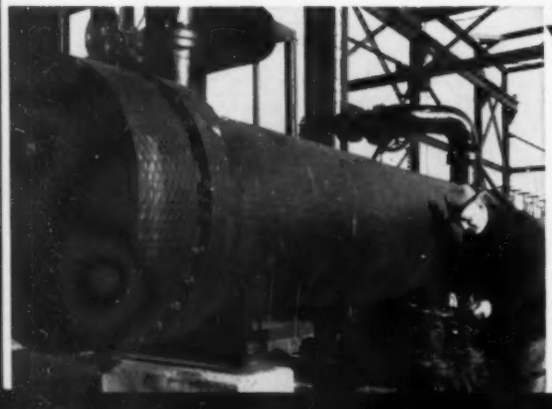
Send for Catalog HT-40 on heat exchangers and CEC 54 on cast iron cooling and condensing sections

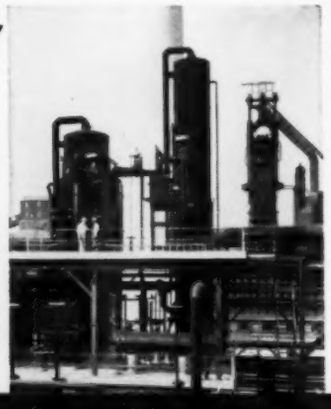
THE HEAT TRANSFER DIVISION
NATIONAL
RADIATOR NRC COMPANY
JOHNSTOWN, PENNSYLVANIA
HEAT TRANSFER DIVISION HEADQUARTERS
60 East 42nd Street, New York 17, New York



Installation of all major coolers in convenient grouping. Left background—Soda solution coolers. Left foreground—Wash Oil Coolers. Right Foreground—Ammonia Liquor Coolers.

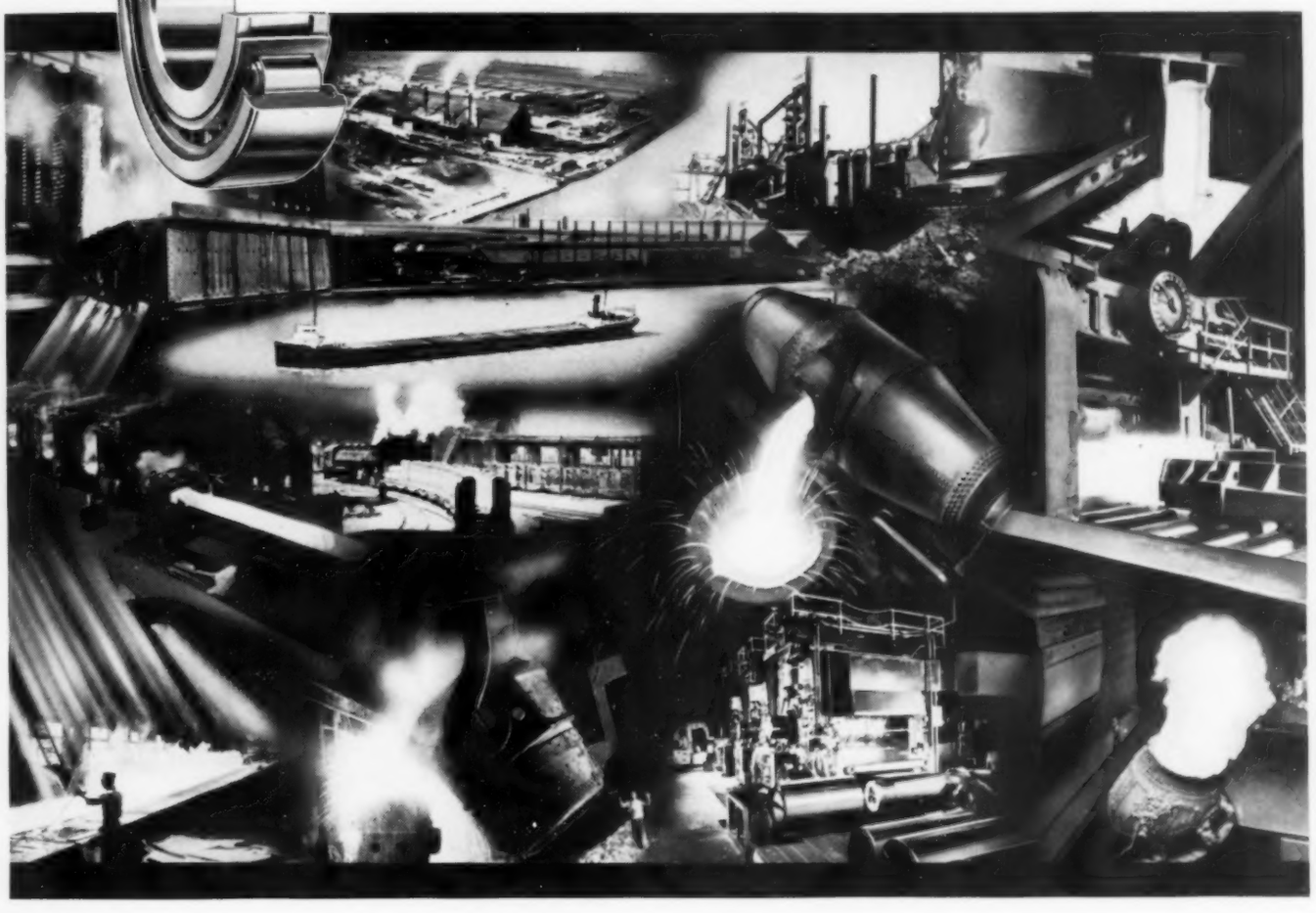
2 views of wash oil preheater—
29" nominal diameter x 12' tube length.





Almost everything that turns at

GREAT LAKES TURNS ON HYATTS!



At the big Ecorse plant of Great Lakes Steel, Detroit division of National Steel Corporation, you'll find HYATT Roller Bearings on the strip mill, the slabbing mill, both blooming mills.

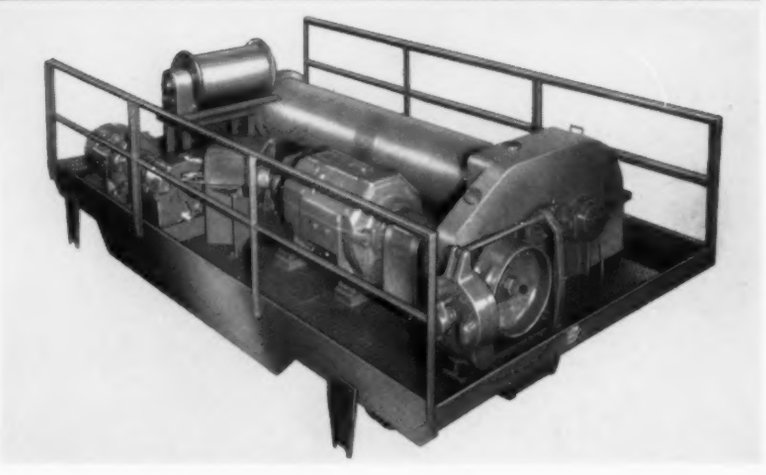
You'll find HYATTS on cranes—mill motors—ingot cars—charging cars.

To keep a steady supply rolling to Detroit's steel-hungry auto assembly lines and many other customers, one of America's foremost steel producers depends on HYATTS. Great Lakes can't afford to depend on anything but the *best* in roller bearings. *Can you?* Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

HYATT ROLLER BEARINGS

STRAIGHT BARREL TAPER

Installation of a 25-Ton A.I.S.E. Crane at Great Lakes Steel slabbing mill.



"Shaw-Box"® CRANES *at* GREAT LAKES STEEL

It has been our good fortune at "Shaw-Box" to have built — in addition to 17 mill cranes — a slab turning gantry, a soaking pit cover carriage, and a plate handling gantry for the Great Lakes Steel Division of National Steel Corporation. All of these cranes have been installed in the very modern and up-to-date plant at Ecorse, Detroit, Michigan.

In "Shaw-Box" Cranes — whether built to an individual mill or to A.I.S.E. specifications — you get the added advantages that come from "Shaw-Box" engineering, fine workmanship, and precision manufacturing methods. These added advantages insure crane performance that makes "Shaw-Box" Cranes — for the work they do — the least expensive to buy and the most profitable to use.

Send All Your Inquiries for Steel Mill Cranes and Soaking Pit Carriages to "Shaw-Box."

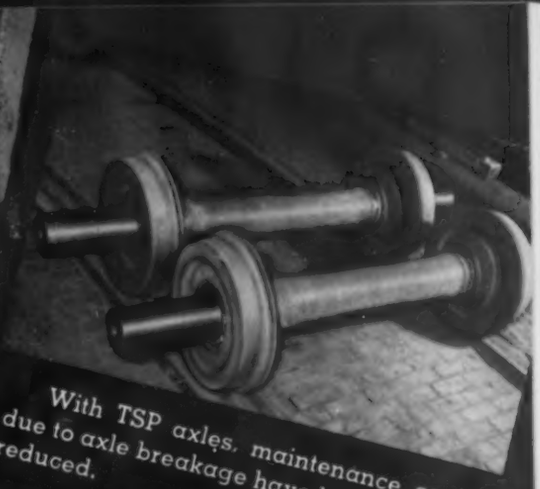
"Shaw-Box" CRANES

MANNING, MAXWELL & MOORE, INC.
Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, 'American' and 'American-Microsen' Industrial Instruments, and Aircraft Products.

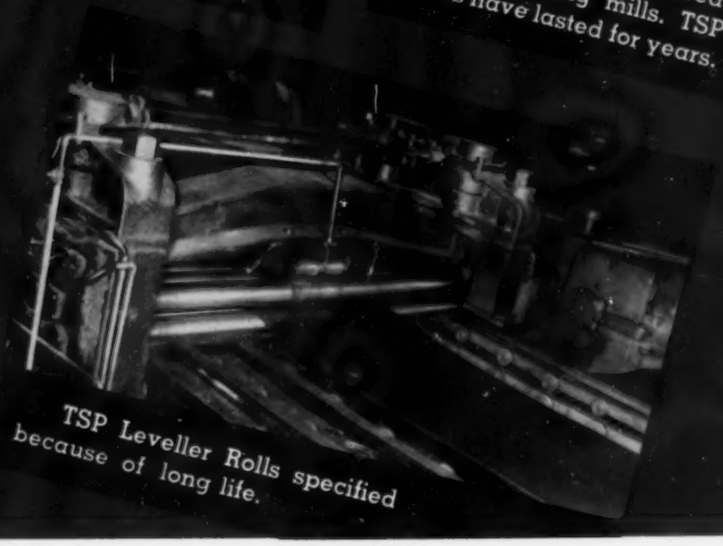
TSP Bevel Gears on mill approaches and delivery tables—very rough service. TSP gears are lasting several times longer than others formerly used.

TSP Liners used on Great Lakes blooming mills. TSP Liners have lasted for years.



With TSP axles, maintenance costs due to axle breakage have been greatly reduced.

TSP Helical Gear on edging mill, under extreme wear conditions for over a year, shows little sign of wear.



TSP Leveller Rolls specified because of long life.

here are 5 reasons why Great Lakes Division of National Steel uses TSP products

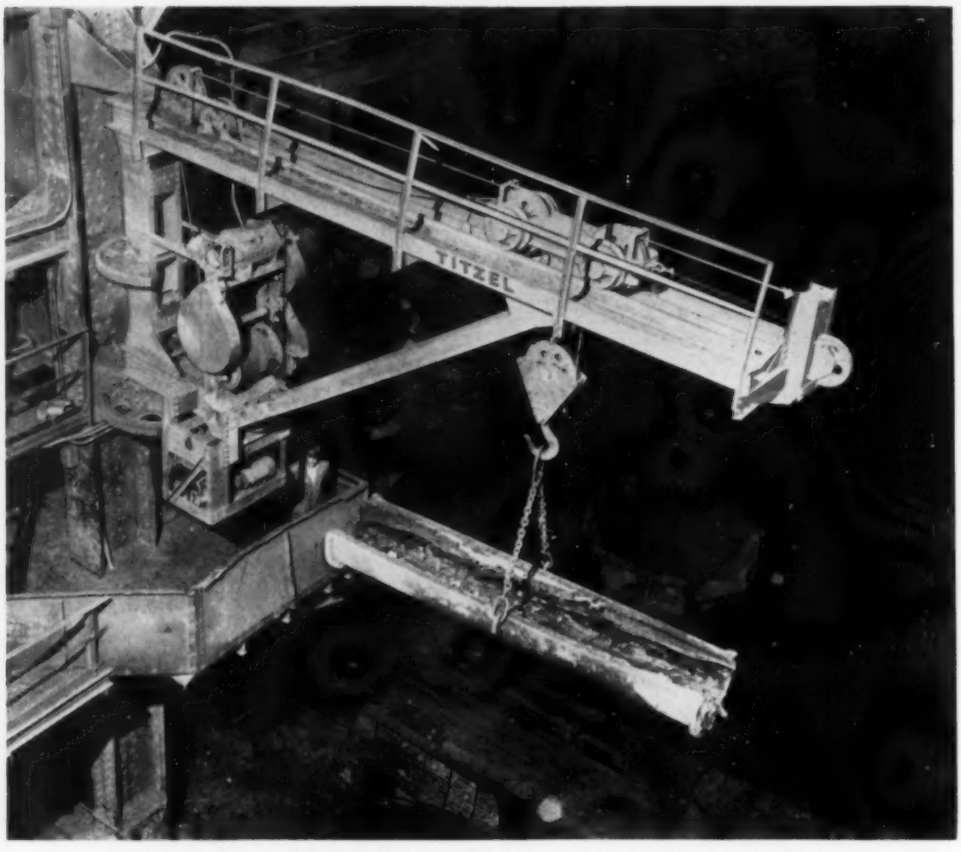
THE TOOL STEEL GEAR AND PINION CO.
CINCINNATI 16, OHIO, U. S. A.

AD No. 1011

The Standard of Quality Since 1909 for Gears • Pinions • Rolls • Wheels and Other Hardened Products

HERE'S WHY: TSP products are hardened by our special process. The file hard surface to full depth of permissible wear gives maximum life. The core, refined for toughness and ductility, gives maximum strength. You receive an absolutely positive written guarantee that TSP products will give longer life in the same service than any other product.

TITZEL STEEL MILL EQUIPMENT



JIB CRANE FOR SPOUT HANDLING AND LADLE REPAIR

STOPPER ROD DRYING OVENS AND HOLDING OVENS

WALL TRAVEL AND FLOOR TRAVEL CRANES
FOR CAPPING AND HOT TOPPING

SKULL AND BUTTON BURNING CRANES

HUNT HYDRAULIC SYSTEM AND CONTROL VALVES

CHEMICAL SYSTEMS AND CHEMICAL MACHINES

PALM OIL RECLAIMING SYSTEMS
AND CENTRIFUGAL SEPARATORS

AND OTHER SPECIAL STEEL MILL EQUIPMENT

TITZEL ENGINEERING, INC.

PITTSBURGH 22, PA.

Uncoiler and side trimmer units of Wean 93" Processing and Shear Line at Great Lakes Steel Corporation.

...A 93" STRIP PROCESSING and SHEAR LINE

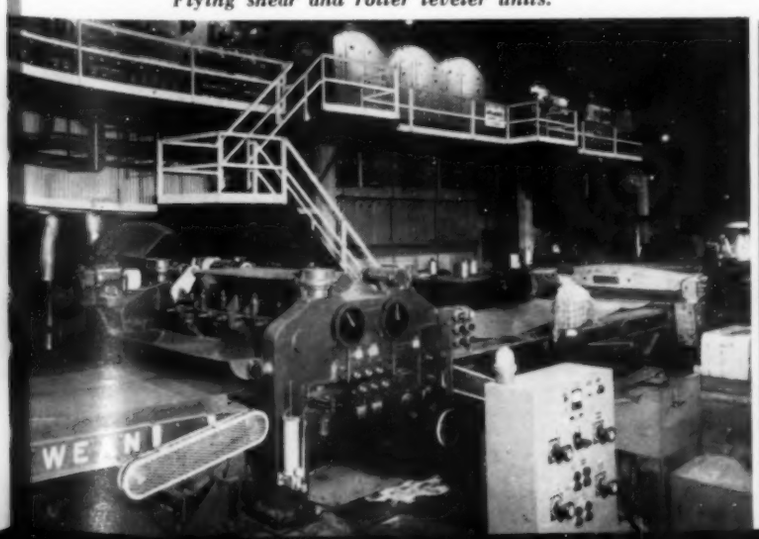
positions
uncoils
shears
levels
piles

To get the most efficient coil-to-sheet operation possible on wide stock, the Great Lakes Steel Corporation, Division of National Steel Corporation, installed a 93" Wean-Hallden hot strip processing and shearing line.
The line will carry 30,000 lb. coils and process steel up to ¼" in thickness. The unit consists of a coil opener, a McKay processing uncoiler and coil car, a side trimmer and scrap chopper, a Hallden guillotine type flying shear, inverted backed-up roller leveler, reject and prime piler.

Great Lakes uses the line for processing mild steel.
If you want faster more efficient processing of steel strip coils—specify Wean—all the way.

The WEAN
ENGINEERING Co. Inc.
Warren Ohio

Flying shear and roller leveler units.



Sheet piler at end of 93" Wean line.

WATER FLOW INCREASED 380%

DOWELL chemically cleaned blast furnace cooling system with furnace on blast, lowering discharge temperature of cooling water 44°F.

A heavy deposit of iron oxide and sludge restricted water flow in the cooling system of a blast furnace. In many places the piping was two-thirds filled with scale, causing hearth cooling blocks to overheat and burn out.

With the furnace on blast, Dowell engineers used solvents to remove the deposits. After chemical cleaning by Dowell, the operator's tests showed water flow had increased over 380% and the discharge temperature had dropped 44 degrees.

Among the many kinds of equipment regularly cleaned by Dowell are pipe lines, boilers, condensers, gas mains, open hearth checkers, stoves and other gas cycle equipment.

Dowell brings job-tailored solvents and the necessary cleaning equipment into your plant. Solvents are applied according to the technique best suited to the job—filling, spraying, jetting, cascading or vaporizing. Dismantling and downtime are eliminated or held to a minimum.

Don't gamble production against scale and sludge. Call your nearest Dowell office for information and estimates on cleaning your equipment. Or write to Dowell Incorporated, Tulsa 1, Oklahoma, Dept. D-29.

chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

Two-Plane Straightener

gives 2-machine performance in one operation

K&R

N-A-X

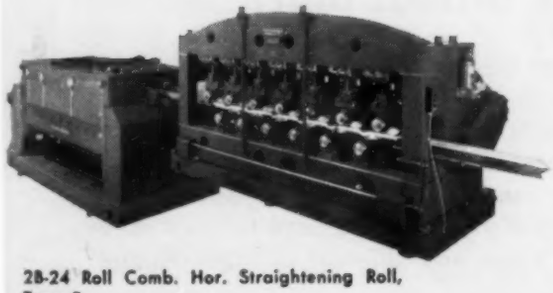
NATIONAL STEEL CORPORATION

Straightening Spring and N-A-X Tensile Steels at Great Lakes Plant, Ecorse, Mich.

The K&R No. 2B-15 Roll Comb. Vert. and Hor. Straightening Roll, Type B, shown in use at the Great Lakes Steel Corporation, Detroit, Michigan, Division of National Steel Corporation, has continued to give satisfactory service since its installation in 1936. This Two-Plane straightener gives the flexibility of operation needed for edge and flat straightening of rectangles, squares, hexagons and other shapes. Flexibility that gives you the advantage of two-machine operation in one pass. *Illustrated are the modern K&R 2B Straightening Rolls, both Two Plane and Single Plane Types.*

Learn how K&R Machinery can cut costs and boost production in your plant. Our engineers will furnish recommendations, operating data, estimates—no cost, no obligation. Write or wire today.

2B-10 Roll Hor. Shaft Straightening Roll, Type B, shown at maximum longitudinal centers, above, and minimum longitudinal centers, below.



2B-24 Roll Comb. Hor. Straightening Roll, Type B.

2B-16 Roll Comb. Hor. and Vert. Straightening Roll, Type B.

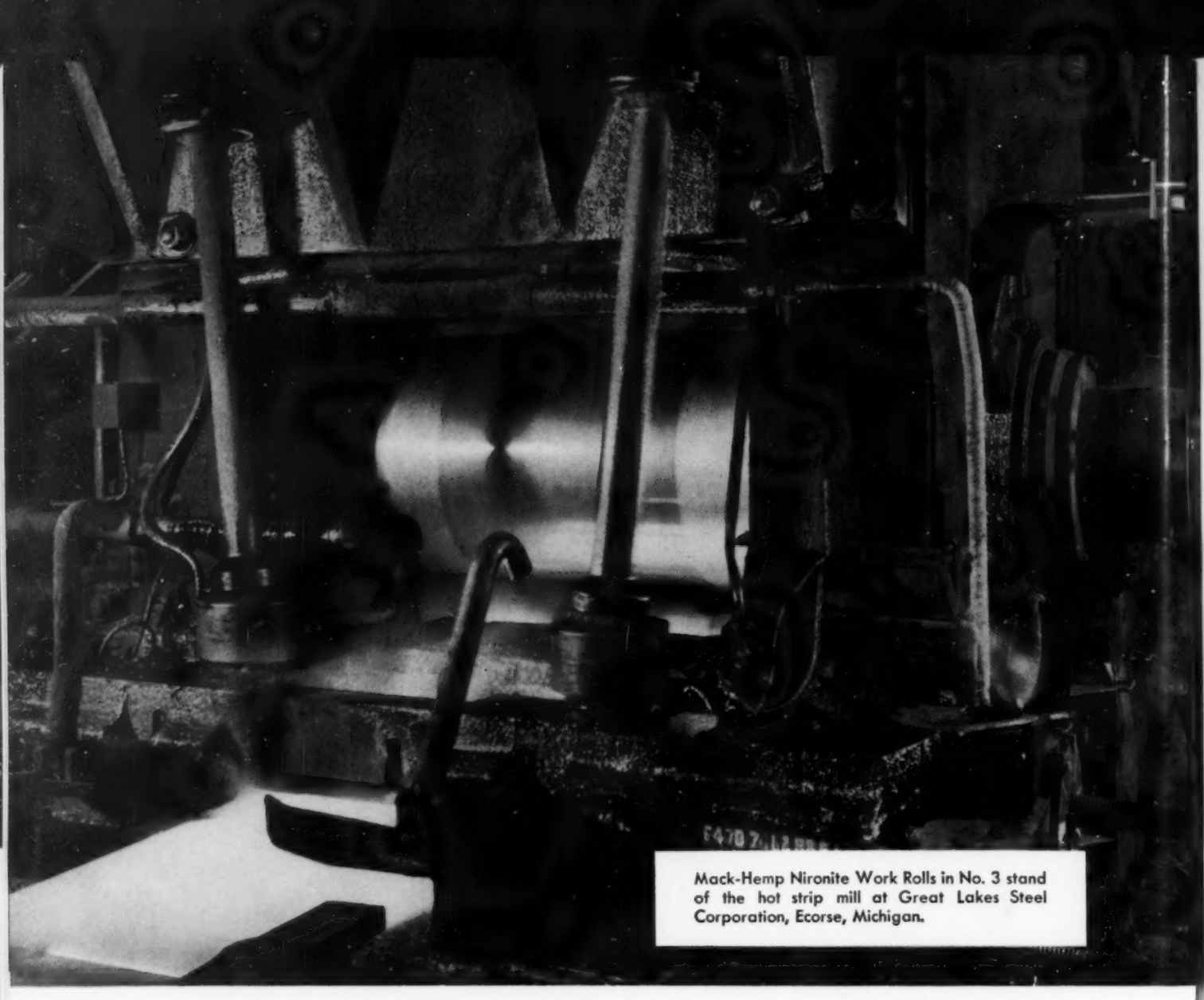
Metal Working Machinery Since 1887

Cold Roll Forming Machines
Bending Rolls Straightening Rolls
Slitting Lines Flying Shears & Saws
Special Metalworking Equipment

Kane & Roach

INCORPORATED

SYRACUSE, NEW YORK • ESTABLISHED 1887



Mack-Hemp Nironite Work Rolls in No. 3 stand of the hot strip mill at Great Lakes Steel Corporation, Ecorse, Michigan.

In the hot strip mill stands of GREAT LAKES STEEL CORPORATION...

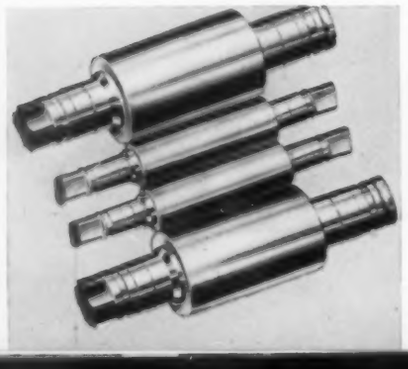
MACK-HEMP Striped Red Wabbler Rolls

set the pace for quality production

Mackintosh-Hemphill points with pride to the important part Striped Red Wabbler Rolls continue to play in assuring top production in the hot strip mills at Great Lakes Steel Corporation, Detroit, Michigan, Division of National Steel Corporation.

Here, as elsewhere, Mack-Hemp Rolls are upholding their well-known reputation for rolling quality steel at modern high production speeds with low operating costs . . . and long service between changes.

Today's prominent steel producers have found through the years that it pays to keep an eye on what's new and different at Mack-Hemp.



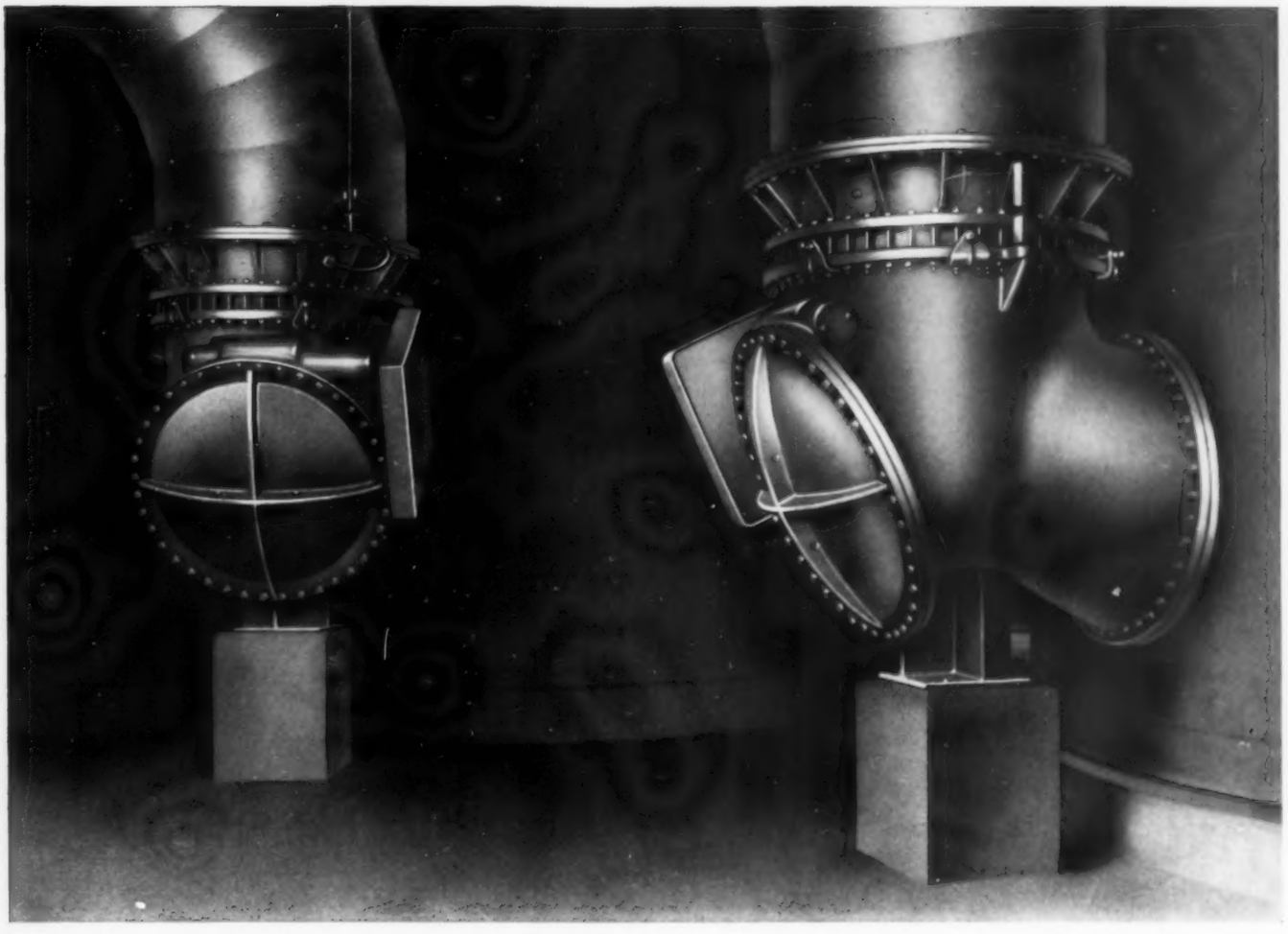
MACKINTOSH-HEMPHILL DIVISION · PITTSBURGH · U.S.A. · BLISS

MACKINTOSH-HEMPHILL
DIVISION
E. W. BLISS COMPANY

Makers of the rolls with the striped red wabblers

PITTSBURGH AND MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: all types of cast mill rolls . . . improved Johnston patented corrugated cinder pots and slag handling equipment . . . Mackintosh-Hemphill rotary straighteners . . . electronically controlled contouring lathes . . . screw feed roll turning lathes . . . heavy-duty engine lathes . . . shears . . . end-thrust bearings . . . steel and special alloy castings . . . reversing hot strip mills . . . Y-type cold strip mills.



622 Freyn-Design Chimney Valves in Service . . .

No Replacements!

The impressive service record of the Freyn-Design Chimney Valve for hot blast stoves is the best proof of its reliability.

It is a mushroom valve of the angle type, in which a simple, positive counterweight mechanism, passing over dead center, locks the disc in open or closed position. The valve disc opens away from the water-cooled seat and, when in the open position, is out of the path of the stream of hot stack gases.

When the spherically-machined disc is closed, stove blast pressure automatically forces a tight, sure closure. The valve can be cycled in less than 30 seconds, and may be operated manually either at the valve or from a floor stand on the floor above. It can also be provided with a motor or compressed air operator.

Freyn-Design Chimney Valves—in both top and bottom discharge design, with and without cold blast connections—have been proved in 622 installations. None has ever been replaced.

Investigate the long-range reliability and economy of Freyn-Design Chimney Valves for your hot blast stoves. We'll be glad to provide you with complete design and cost information. Write or call today!

KOPPERS

KOPPERS COMPANY, INC.

Freyn Department

Engineering & Construction Division

KOPPERS BUILDING • PITTSBURGH 19 *Associated with* Ashmore, Benson Pease & Co. Ltd., Stockton-on-Tees, ENGLAND; De Lattre & Frouard, Paris, FRANCE

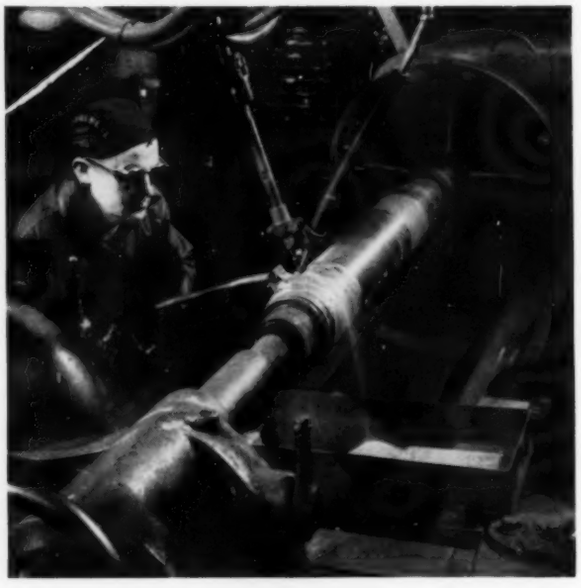
COAST METALS

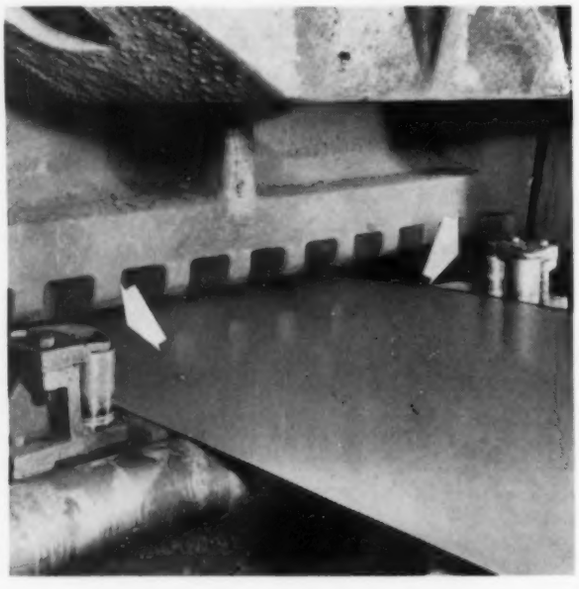
HARDSURFACING ALLOYS
WEAR PREVENTIVE CASTINGS

In use at Great Lakes Steel Corp., Detroit Division of National Steel Corporation
OVER 15 YEARS

HARDSURFACING

—for manual and automatic welding. Coast Metals Hardsurfacing gives maximum service under the severe heat and abrasion of steel making and finishing operations. Photo shows a 6" leveler roll for the strip finishing mill, being automatically welded with Coast Metals "X" wire.





WEAR PREVENTIVE CASTINGS

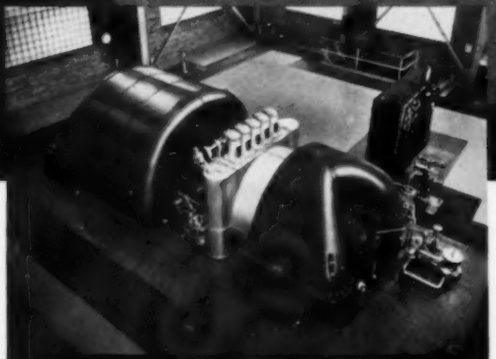
Roller guides, twist rolls, edging rolls, and many other vulnerable parts, deliver greatest tonnage when cast in a Coast Metals alloy. Photo shows Coast Metals vertical guide rolls in service on the No. 2 continuous pickler.

COAST METALS, Inc.
Little Ferry, N. J.
COAST METALS (CANADA), LTD., Hamilton, Ontario

PRODUCERS OF HARD FACING WELDING RODS AND WEAR RESISTANT CASTINGS

fourteen I-R Turbo-Blowers serve the Ecorse plant of GREAT LAKES STEEL

Above (left) is latest I-R 125,000 cfm, 35 psig, 15,750 hp blower for Blast Furnace A. At right is 60,000 cfm, 30 psig, 7,000 hp unit installed in 1936.



This 125,000 cfm I-R Turbo-Blower serves D furnace on a round-the-clock basis with no standby source of "wind."

Four I-R 27,000 cfm, 6 psig, 1,000 hp Coke Oven Gas Boosters, with Adjustable Inlet Guide Vanes and Power Wheel for efficient part load operation.

IN THE huge, modern plant of the Great Lakes Steel Corporation, Detroit, Mich., division of National Steel Corporation, fourteen I-R Turbo-Blowers with a combined capacity of more than 650,000 cfm serve the blast furnaces, converters and coke ovens.

These fourteen units include:

2	125,000 cfm	35 psig	Blast Furnace Blowers
1	60,000 cfm	30 psig	Blast Furnace Blower
4	45,000 cfm	30 psig	Bessemer Converter Blowers
4	27,000 cfm	6 psig	Coke Oven Gas Boosters
3	19,800 cfm	4¾ psig	Coke Oven Gas Exhausters

The blast furnace blowers are all turbine-driven and served by I-R surface condensers and auxiliaries. And all of the Converter Blowers and Gas Boosters are provided with I-R power-saving Adjustable Guide Vanes and Power Wheel assemblies.

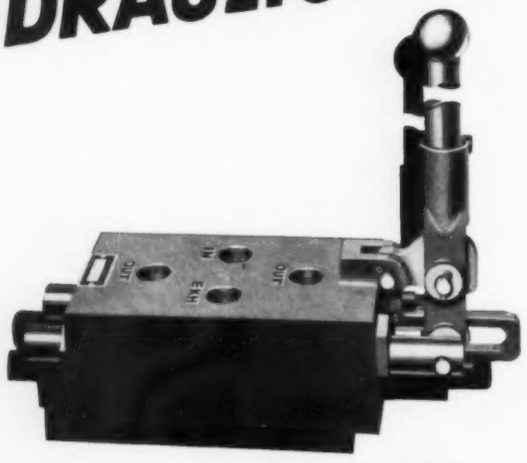
Here at Great Lakes Steel, *confidence* in Ingersoll-Rand blowers is based on 19 years of on-the-job performance in continuous, heavy-duty service.

12-230

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS • AIR TOOLS • ROCK DRILLS • TURBO-BLOWERS • CONDENSERS • CENTRIFUGAL PUMPS • DIESEL AND GAS ENGINES

Quick-As-Wink®
HYDRAULIC VALVES

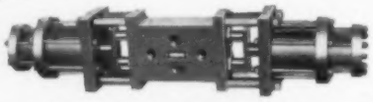


Hand Lever and Pilot Cylinder Types—pressures to 5000 psi.

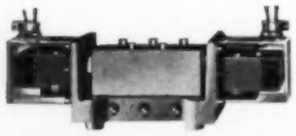
Have won industry wide recognition
for unsurpassed dependability

• Positive and fast acting, Quick-As-Wink Control Valves are designed and built to meet the most exacting requirements. Bodies of hydraulic valves are either forged or milled from solid bars. The hollow, radially ported, stainless steel plungers are chrome plated and polished to minimize wear. All parts are readily accessible and maintenance—that consists mostly of the very occasional replacement of the packing — can be done easily **in the field** without even disconnecting the piping. This avoids the necessity of returning valves to the factory for servicing or maintaining large standby inventories. Let us recommend the sizes and types that will meet your requirements best. Write for Bulletin 531. It gives full details.

Ask us also about . . .



DOUBLE PILOT CYLINDER HYDRAULIC VALVES operated with air or hydraulic pilot cylinders—3 position; neutral, compound-on or compound-exhaust.



DOUBLE SOLENOID "O-TYPE" VALVES for pressures up to 125 psi. Widely used as pilot valves and for operating air cylinders.

Quick-As-Wink
AIR AND HYDRAULIC
Control Valves

Hand, Foot, Cam, Pilot, Diaphragm and Solenoid Operated

***Mfd. by* C. B. HUNT & SON, INC., 1925 East Pershing St., Salem, Ohio**

WHERE TO BUY THEM

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CALIFORNIA . . . Pasadena 8 Circle Seal Supply Co. 2181 E. Foothill Blvd.	Sycamore 3-9195
CALIFORNIA . . . San Francisco 11 James P. Wilbee 420 Market St.	Yukon 6-3799
COLORADO . . . Denver 11 Process Equipment Co. 1663 Central St.	Grand 7341
CONNECTICUT . . . Meriden John S. Diefenbach 350 Lydale Place	BEverly 5-3155
ILLINOIS . . . Chicago 20 G. R. Carrier 8848 S. Ada Street	Hilltop 5-6300
INDIANA . . . Indianapolis 20 National Engineering Co. 5775 Hillside Ave.	Glendale 1132
INDIANA . . . (Northern Part) Leaser Engineering Co. P. O. Box 68 Three Oaks, Mich.	Three Oaks (Mich.) 4881
KENTUCKY . . . Louisville 3 The Alfred Halliday Co., Inc. 719 - 21 S. Preston St.	Wabash 4786 - 3903
MICHIGAN . . . Detroit 1 J. N. Fauver Co., Inc. 49 W. Hancock Ave.	Temple 2-4115
MICHIGAN . . . Flint 4 J. N. Fauver Co., Inc. 2762 Thomas Ave.	Flint 5-5392
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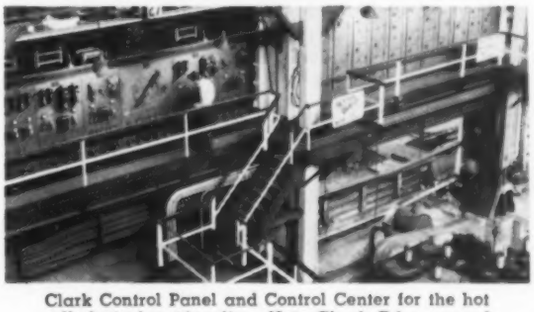
TEXAS . . . Houston 3 Glidden Engr. & Equip. Co. 2111 Hussion Street	Charter 6471-2
CANADA . . . Ontario, Toronto 9 Powerlite Devices, Ltd. 1870 Davenport Rd.	Rodney 1141

Vital Functions at the mills of Great Lakes Steel are CLARK CONTROLLED

● Throughout the huge mills of Great Lakes Steel, Detroit, Michigan, Division of National Steel Corporation, vital production and handling operations depend on Clark Control. Illustrated above, for example, is Great Lakes' mammoth stacking conveyor system, linking ship-to-shore unloading and piling of coal and limestone for blast furnaces at Zug Island. Designed and built by Hewitt-Robbins, this travelling stacker—perhaps the largest in the world, handles coal from boats at the rate of 2,500 tons per hour. To maintain production during ice-bound months, it is planned ultimately to stockpile 500,000 tons of limestone and 350,000 tons of coal . . . Clark Bulletin 6080 Reduced Voltage Starters are used on the AC drive motors for this conveyor.

Great Lakes standardized on Clark Bulletin 110 Edgewound Resistors for much of its production and handling equipment, such as this Hot Metal Crane.



Clark Control Panel and Control Center for the hot rolled steel cutting line. Note Clark Edgewound Resistors at top of panel.

The CLARK CONTROLLER *Company*

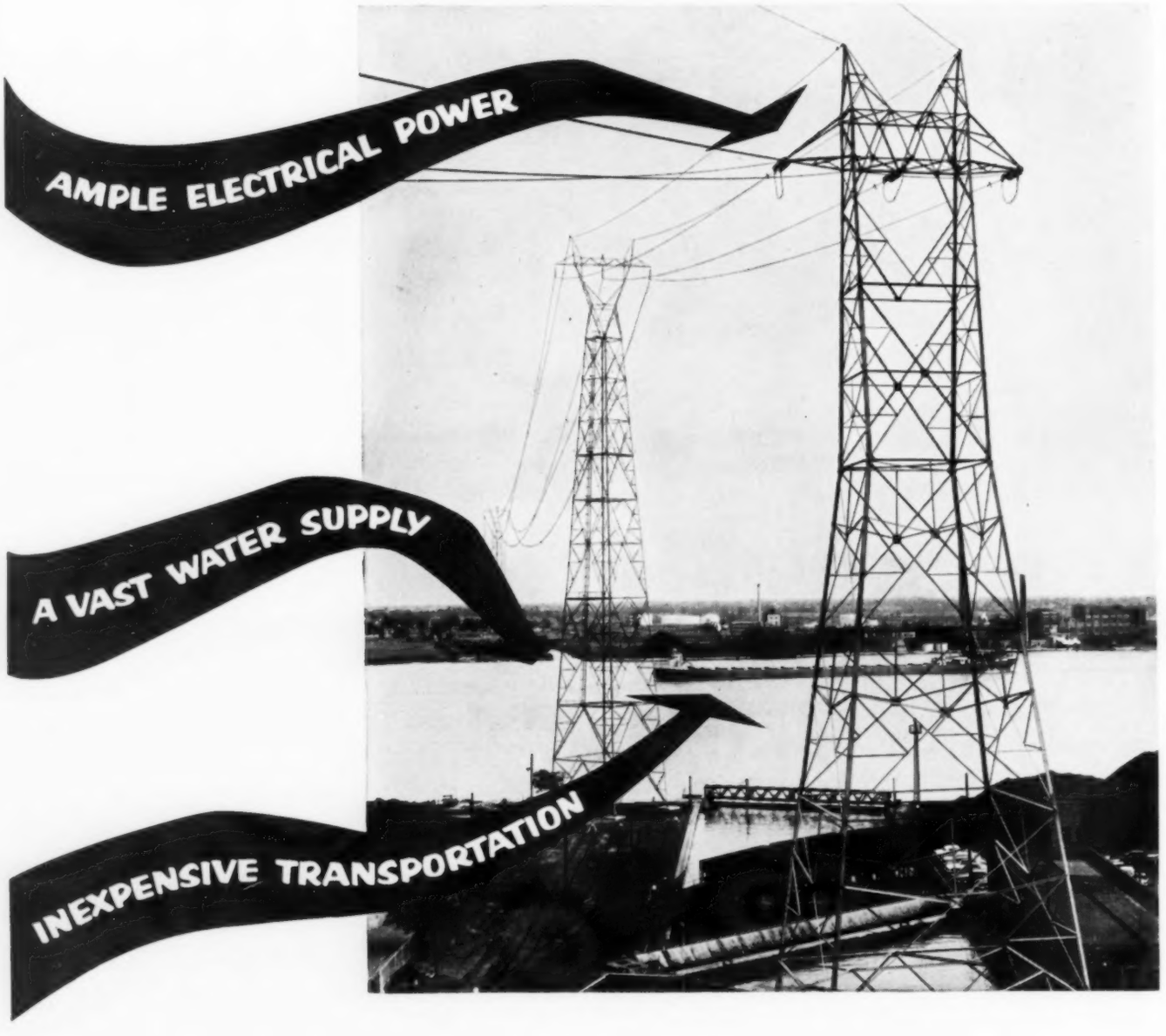
Engineered Electrical Control

1146 East 152nd Street • • Cleveland 10, Ohio

IN CANADA: CANADIAN CONTROLLERS LIMITED • MAIN OFFICES AND PLANT, TORONTO

SOUTHEASTERN MICHIGAN OFFERS . . .

just what it takes to make <u>your</u> plant grow!



THE Southeastern Michigan area offers new industries adequate supplies of water and power and low-cost transportation. To further insure ample electric power, Detroit Edison recently completed the largest international power exchange in the world between Michigan and Canada.

Our great waterways provide plenty of water for industrial processes. And, in their dual role, they carry more freight tonnage per year than any other river system—over 33 per cent more than the Mississippi! In fact, Detroit is America's fourth largest port in both imports and exports.

Add the area's strategic nearness to markets and raw materials and you see why we say—come to Southeastern Michigan and watch *your* plant grow!

Edison's Area Development Division is prepared to assist both industries and communities with their problems of location and development.

For further information write

THE DETROIT EDISON COMPANY

MULTI-DUTY AIR FILTERS SERVE GREAT LAKES STEEL FROM 1930 TO 1955

Modern version of AAF Multi-Duty Self-Cleaning Air Filters which have served Great Lakes Steel for 25 years.

IN 1930, Great Lakes Steel Division of National Steel Corporation installed its first automatic, self-cleaning Multi-Duty Air Filters. During the intervening 25 years, this company has been a continuous user of these and other AAF filters—with the most recent shipment of Multi-Dutys being made to Ecorse in January of this year.

Today, as in 1930, the Multi-Duty remains a steel mill favorite for supplying clean air for motor room ventilation and blast furnace operation. This self-cleaning filter is designed for heavy dust loads. Continuous, automatic cleaning of the filter curtain assures both constant efficiency and uniform air delivery regardless of dust load. Its operating resistance remains fixed, when once established for a given dust concentration—requires no attention other than periodic inspection and removal of sludge at regular intervals.

If you want truly clean air, continuously at lowest possible cost, you've got a job for Multi-Duty—the air filter "veteran" of the American Steel Industry.

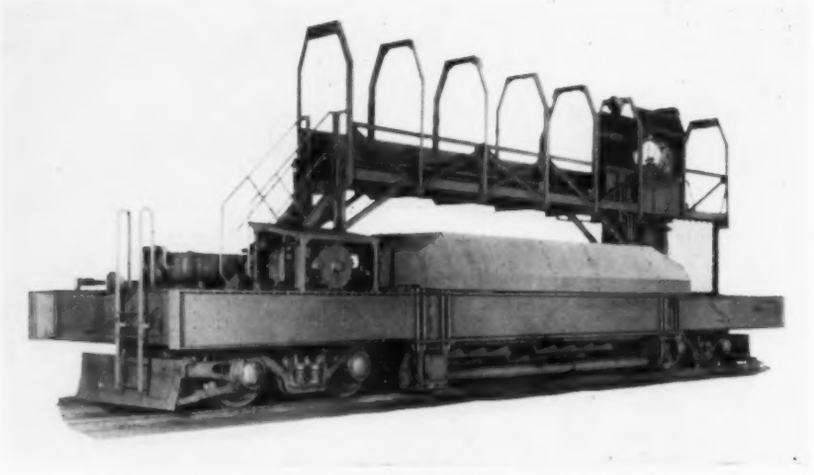
AAF herman nelson

American Air Filter
COMPANY, INC.

American Air Filter of Canada, Ltd., Montreal, P. Q. • 302 Central Avenue, Louisville 8, Kentucky

50-TON BOTTOM DUMP ORE TRANSFER

THESE ATLAS CARS ASSURE GREAT LAKES STEEL DEPENDABLE BULK HANDLING



40-TON DOUBLE HOPPER, CENTER DUMP SCALE CAR

In addition to the Transfer and Scale Car shown here, Atlas furnished the Great Lakes Steel Corporation cars for handling strip steel in the mill as well as Coke Quenching Cars.

Manufacturers of Ore Transfer Cars ★ Scale Cars ★ Coal Charging Cars ★ Door Operators ★ Coke Quenching Cars ★ Coal and Metal Mining Locomotives

THE ATLAS CAR AND MANUFACTURING CO.

ENGINEERS AND MANUFACTURERS SINCE 1896

1140 IVANHOE ROAD — CLEVELAND 10, OHIO

GL-68

Cleveland 1000 AT size speed reducer installed on a furnace pusher at Great Lakes Steel's No. 2 high speed mill, Ecorse, Mich.

1067 Cleveland drives at Great Lakes Steel serve continuously, dependably

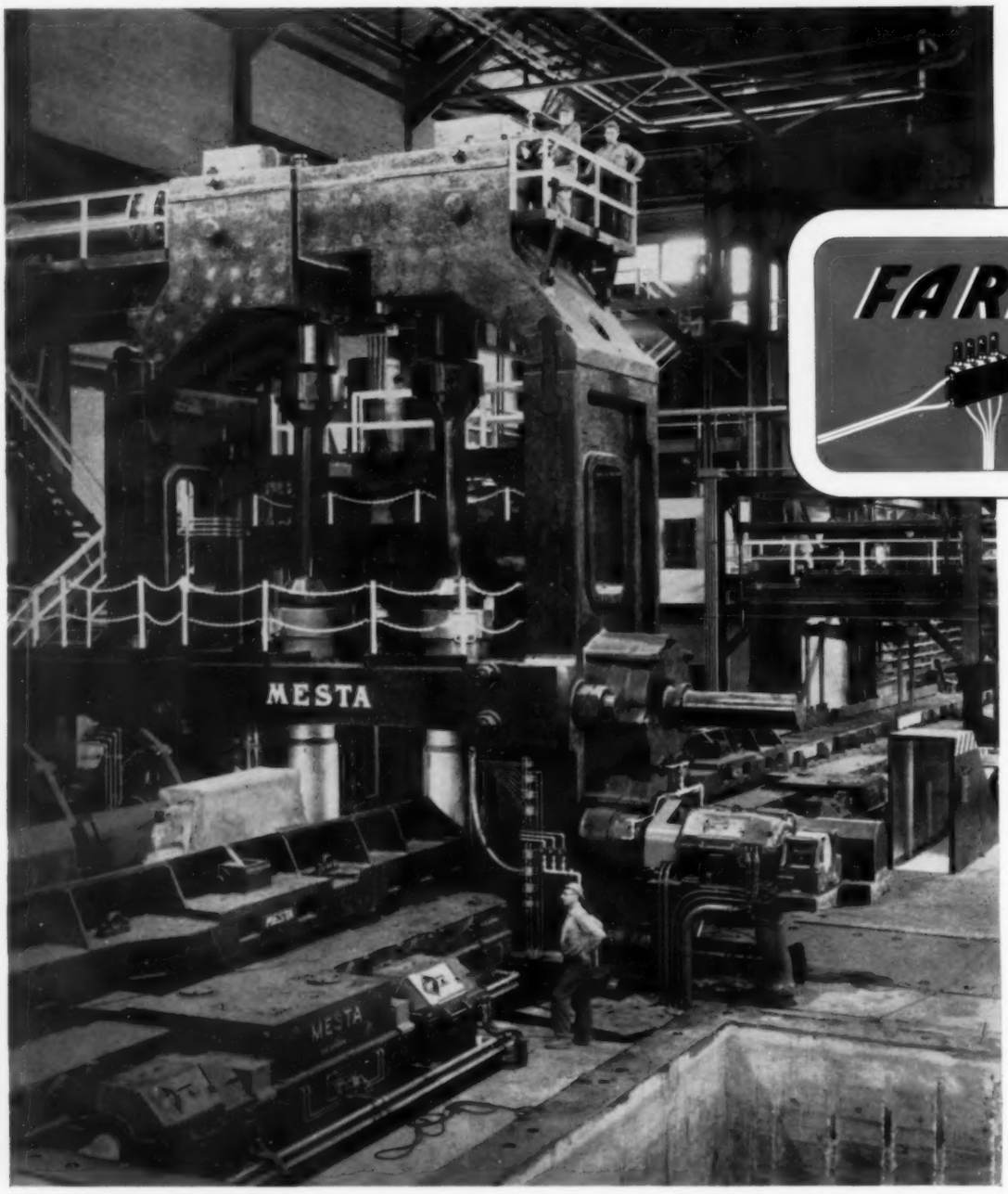
SATISFACTION with Cleveland worm gear drives by users is typified by Great Lakes Steel Corporation, Detroit, Mich., division of National Steel Corporation, which specified them in over a thousand speed reducers and worm gear sets built into many types of equipment.

Such volume installation of Cleveland drives in a steel mill is the usual thing. In almost any steel plant you'll find Clevelands efficiently operating roll drives, cold strip reels, pit cover drives, roll grinders, flying shears, belt wrappers, adjustable side guards, coal grizzlies, conveyors, elevators, hoists and cranes, run out tables, cooling tables, levellers, pickling machines, sintering machines, wire and rod drawing machines, hot and cold strip mills, tube mills, open hearth door lifts, furnace pushers and scores more applications.

Steel men have relied upon Cleveland drives for over 40 years. And Clevelands have never let them down—have consistently given dependable, economical service day-in-and-day-out. For information about Cleveland worm gear drives, write for Catalog 400. The Cleveland Worm Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers



FARVAL

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Applications of High Velocity Combustion to the Steel Industry

. . . . used judiciously in the right applications, high velocity burners should find many applications in the steel industry . . . . because of extremely high heat release rates, compact and economical designs can be obtained . . . .

By LEONARD C. PESKIN
President
Thermal Research and Engineering Corp.
Conshohocken, Pa.

▲ FOR more than ten years the phenomenon of combustion has been undergoing intensive research in many of the finest scientific institutions. For the most part these investigations have been directed towards meeting the needs of the military. Many valuable discoveries have been made, some of which form the basis for the industrial development to be described in this paper. However, for all the capable talent applied to these studies, the technology of combustion continues to be as much the practice of an art as that of a science. Such a state of affairs inevitably leads to much controversy in which established fact is frequently intermingled with pure conjecture. Nevertheless, some new techniques in combustion have been developed which can be of great value to industry if properly understood and practiced. One of these is the application of high thermal release.

High thermal or high heat release is a rather loosely stated term. It implies the release of heat from a combustion process in terms of millions of Btu per cu ft of combustion space per hr, rather than the more customary thousands of Btu per cu ft per hr. However, this in itself is not new, for high heat release has been created for many years by a variety of methods, including the use of acetylene, oxygen and even special catalysts. While these special fuel and oxygen techniques can and do play a part in the industrial processes of today, what we are concerned with in this paper is a method of obtaining and applying high heat release through the use of the ordinary fuel-air mixtures common to industry.

Since most metallurgical processes involve heat, a faster heat processing which at the same time is trouble-free, economical and capable of yielding a quality product is universally desirable. Such an objective can be achieved by use of the high velocity combustion technique for the production of high heat release.

THE CREATION OF HIGH VELOCITY COMBUSTION

The investigations of the military into high heat release was inspired by the need for releasing a gas turbine, ram jet, or similar thermal power system, tremendous amounts of energy in as small, light, and reasonably durable a structure as possible. The resulting highly specialized equipment is not normally acceptable to industry.

Approximately five years ago, a small group in the author's company set out to apply a high velocity combustion technique that would meet the wide needs of industry. This has been accomplished in many applications and it is hoped that this discussion will result in a better understanding of this development.

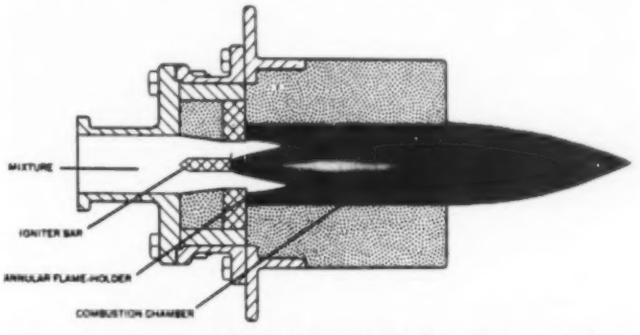


Figure 1 — Cross section through high velocity combustion gas burner.

High velocity combustion consists basically of carrying out an exothermic reaction between hydrocarbon and oxidant in which the mass velocity upstream of the burning zone is high enough to provide stable burning at release rates in the millions of Btu per cu ft per hr. Although commonly called burners, a number of com-

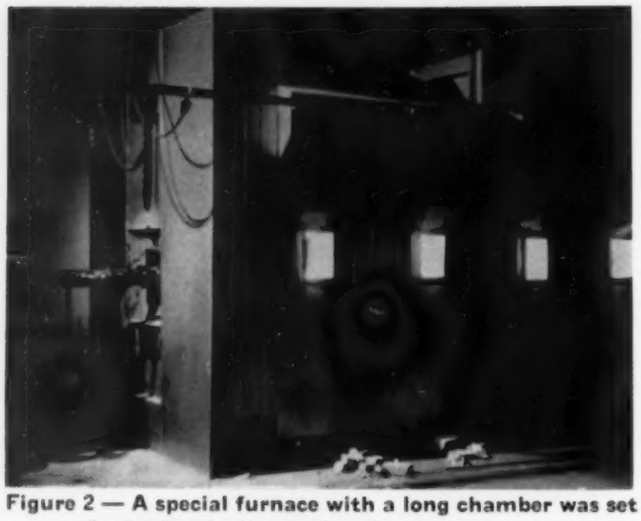


Figure 2 — A special furnace with a long chamber was set up for high velocity combustion tests.

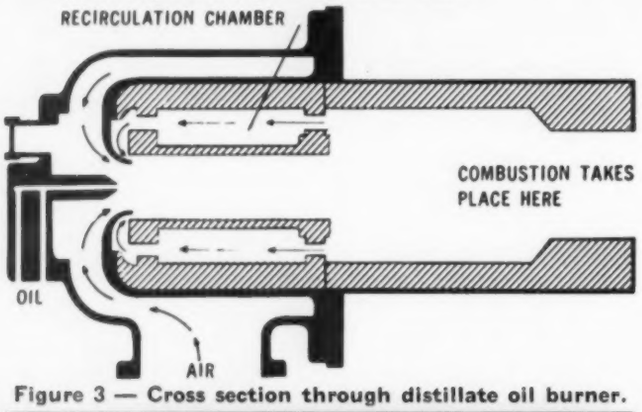
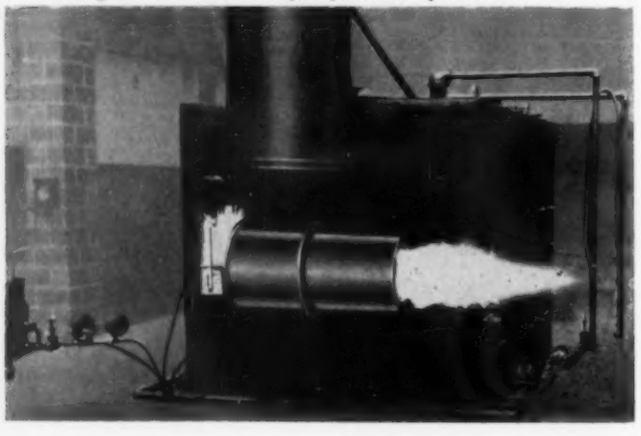


Figure 3 — Cross section through distillate oil burner.

Figure 4 — Distillate oil burner is shown in operation. Note burner flame.

Figure 5 — Note appearance of flame in residual oil burner using a No. 6 oil at 10,000,000 Btu per hour.



bustor designs which provide high velocity combustion are discussed in the following figures.

Figure 1 shows a cross-section of a high velocity combustion gas burner. Flame holding devices are incorporated to provide for flame stability over all conditions of pressure, temperature and flow of mixture. The combustion process is about 90 per cent complete in the refractory combustion chamber. Normal exit velocities are about 400 fps when using a 16-oz blower but can be increased to over 1000 fps by means of higher pressures and specially shaped exit nozzles which are also utilized for many localized heating requirements. Flame temperatures near theoretical can be reached as well as highly reducing or highly oxidizing combustion gas analyses. The heat release rate is over 10,000,000 Btu per cfhr.

Tests were made to determine at what distance from the burner nozzle can such a high velocity stream of hot gas still be effective for heat transfer. Figure 2 shows a long furnace chamber provided with test ports by which comparative heat transfer measurements were made with thermocouples imbedded in 2 × 2-in. steel billets. At the maximum distance for this furnace of approximately 21 ft, the velocity effect of the hot blast was enough to increase the heat transfer rate by 12 per cent over that due to the 2250 F wall radiation condition alone.

Figure 3 is a cross-section of a distillate oil burner for producing similar results. As with the gas burner, means for flame holding are provided, plus one important additional feature made necessary by the inherent slow burning characteristics of a liquid fuel. This is a means for vaporization which utilizes heat from the combustion zone to vaporize the fuel prior to burning and within the confines of the burner. The resultant flame is clear as with the gas burner. The same high velocity and high temperatures as well as broad fuel-air ratio ranges are possible. The heat release rate is over 10,000,000 Btu per cfhr. The development of this burner is described in detail in Reference 1 in the bibliography. Figure 4 shows this burner in operation.

While the previous remarks concerning the oil burner have been confined to the use of distillate oil as the fuel, intensive work has been going on for a number of years on obtaining the same type of vaporizing combustion with residual fuel oil. Figure 5 shows the result of effort in this direction. Here is seen the burning of No. 6 oil at 10,000,000 Btu per hr at a heat release rate that is considerably in excess of 3,000,000 Btu per cfhr. The luminosity of this flame is due to those particles in the fuel which cannot be vaporized, such as the ash content. Close observation of the flame shows a high degree of transparency, an extremely clean flame, and little or no carbon dust in the products of combustion. The basic burner design is very similar to the distillate oil burner in that recycling is used to provide the heat for vaporization. Certain modifications have been incorporated to prevent any carbon build-up within the burner. While the rate of heat release is not quite as high as with the faster burning distillate oils and gas, it nevertheless takes place in the combustion chamber to the extent that the resulting products of combustion exit with the same order of high velocities. The burning is clean, with a very minimum of radiation and again

at near theoretical temperatures. It is expected that commercial versions of this heavy oil burner can be made available to industry in a number of sizes within the next few months.

Since the liquid fuel burners described are actually made to burn a generated gas or vapor, prior to combustion, it is apparent that a combination gas-oil version would involve only a minor modification. Figure 6 shows

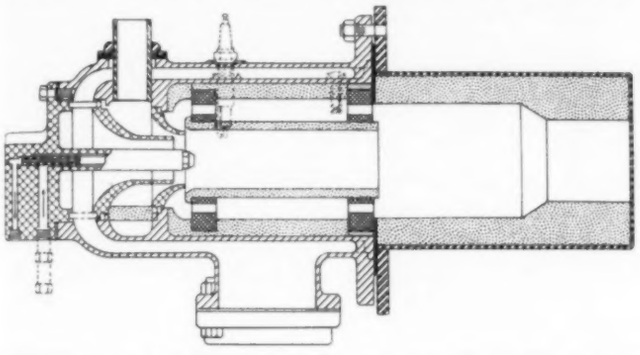


Figure 6 — Cross section through combination gas-oil burner.

such a unit. This high velocity system is particularly unique in that the flame characteristics are the same with either gas or oil as the fuel. Gas temperatures, velocities and radiation characteristics are practically identical. This can be of utmost importance in those processes where flame characteristics must be maintained when changing fuels.

For those applications where extremely wide temperature levels are needed, with accurate control of heating and cooling cycles, a modification of the high velocity burner permits the use of large quantities of excess air. Figure 7 shows the details and it will be

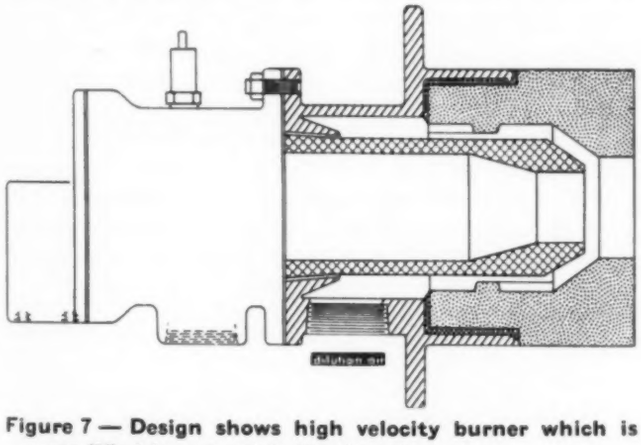


Figure 7 — Design shows high velocity burner which is modified for use with dilution air.

noted that the dilution air is introduced downstream of the combustion chamber of the burner so that none of the burning fuel-air mixture is chilled, which could cause poor combustion efficiency. The burner shown produces products of combustion with temperatures as low as 250 F to over 3000 F by simply varying the relative amounts of dilution air and burner output.

Standard accessories, such as blowers, pumps, regulators, valves, etc., are used with the burners described. The arrangement of accessories for a high velocity burner installation is very similar to that of any conventional equipment.

HEAT TRANSFER CHARACTERISTICS OF HIGH VELOCITY COMBUSTION

The preceding has described some new basic industrial equipment for creating a high heat release rate by means of combustion at high velocity. This combustion technique has certain characteristics which suggest some changes in the design of heat equipment. Products of combustion at velocities of 400 fps, flame temperatures at over 3000 F, and extremely low flame emissivity can readily result in a furnace or other heat equipment taking a very different form from the conventional. Obviously, the completion of combustion within the burner proper and the injection of products of combustion directly into the furnace is in itself a means of greatly reducing the physical size of the equipment. Before going further, however, into the effect of the high velocity combustion on the heat equipment or process, it would be well to examine classical relationships which describe the heat transfer process.

The transfer of heat energy can occur by three mechanisms, singly or in combination. These mechanisms or processes are known as conduction, convection, and radiation. In this discussion will be examined some of the aspects of heat transfer from flames and combustion products. The job will be to consider what is involved in getting heat from its point of release in a combustion zone to the place where it will be used. In many practical situations, this means getting heat into a solid surface such as a boiler tube or metal ingot. The solid surface, more often than not, is at some distance from the point of heat release. Therefore, both the transport of heat through distance and its transfer into a surface must be considered. It turns out that convection and radiation are of primary interest in this problem so attention will be confined to these two mechanisms.

The simple transport of heat through distance — Consider the job of transferring maximum heat as rapidly as possible from one place to another. Suppose there is a passageway which is one sq ft in cross section. Obviously, the method which provides the greatest flux of heat past any arbitrary observation post along the passage will be the best for this purpose. This assumes, of course, a steady state condition and continuity, i.e. identical rates, at all points along the passage. In order to have something to work with assume that the source of heat is a body of gas at 3600 F, that its properties are very nearly like those of air except that it has an emissivity of unity and is thus a perfect black body radiator. Further assume that the sink to which the heat is carried is at 0 F. The emissive power of a radiating body, in this case gas, can be represented by the well known Stefan-Boltzmann law (Reference 2):

$$W = \tau \epsilon T^4 \qquad (1)$$

where W is the emission in Btu per hr per sq ft of radiating surface, ϵ is the fraction of emission which a perfect radiator (black body) would emit, τ is a constant having the value 0.173×10^{-8} Btu per sq ft, per hr per (degree R)^4 and T is the absolute temperature in degrees Rankine.

Equation (1) tells us that the maximum thermal flux which could enter our passage by radiation alone is about 130 Btu per sec. This represents the maximum rate at which we can transport heat along the passage

by radiation. Incidentally, it was assumed that the sink had perfect absorptivity and was at a low enough temperature so that back radiation would be negligible.

Now let us allow the combustion gases at a temperature of 3600 F to flow through the passage at the modest velocity of 100 fps. The thermal flux (Q_c) due to convection is given by the relation:

$$Q_c = Ah\rho V \qquad (2)$$

where A is the passage area, h the enthalpy of the hot gases (assumed to be approximately that of air) above 0 F, ρ the gas density (assumed at essentially atmospheric pressure), and V the gas velocity. This calculation quickly shows that the thermal flux through the passage by convection is at least 10 times greater than is possible by radiation. If we use a little larger blower we could easily push the hot gas at 500 fps and achieve 50 times the heat flux.

To reassure ourselves we can look back at equation(1). Surely, we note that by increasing the source temperature a little we could greatly increase the radiative flux because it rises with the fourth power of the temperature. The convective flux would increase roughly only with the first power of the temperature. Therefore, there must exist some temperature at which the radiative flux would be greater than the convective flux at the gas velocities we have considered. Unfortunately, 3600 F is just about as high a temperature as can be realized by the combustion of ordinary fuels with air. In fact, it is somewhat higher than can be obtained if a high emissivity (i.e. sooty) flame is desired. From a practical standpoint it is more instructive to consider what might happen at lower temperatures. This is especially true in view of the fact that for most applications there is useful heat left in the combustion products down to temperatures of the order of 300 to 500 F.

The situation is summarized in Figure 8. The ratio of convective flux to radiative flux is plotted against the source temperature. Instead of assigning particular gas velocities, curves are shown for source (i.e. blower) pressures of 1.0 and 0.1 psig. The relation between velocity and pressure for incompressible flow can be expressed as:

$$V = \sqrt{\frac{2g\,\Delta p}{\rho}} \qquad (3)$$

where the symbols are as previously given and Δp, the pressure drop is assumed to be all that is available from the blower. This means that there will be different velocities at different temperatures but it relates directly to the practical situation in which the draft pressure is fixed. It does not take long to realize that when it comes to moving heat around from one place to another radiation is not in the same class with convection. This is in spite of the fact that radiant energy travels with the speed of light, some 186,000 miles per sec. Our gas stream is moving only at a few hundred ft per sec. The answer, of course, is in the energy density per unit volume. A gas is capable of containing many times as much heat as an equivalent volume of free space containing electromagnetic waves from sources of the intensity (temperature) that we contemplate.

To be sure the comparison is a crude one. It is only fair to point out, for example, that convective transfer

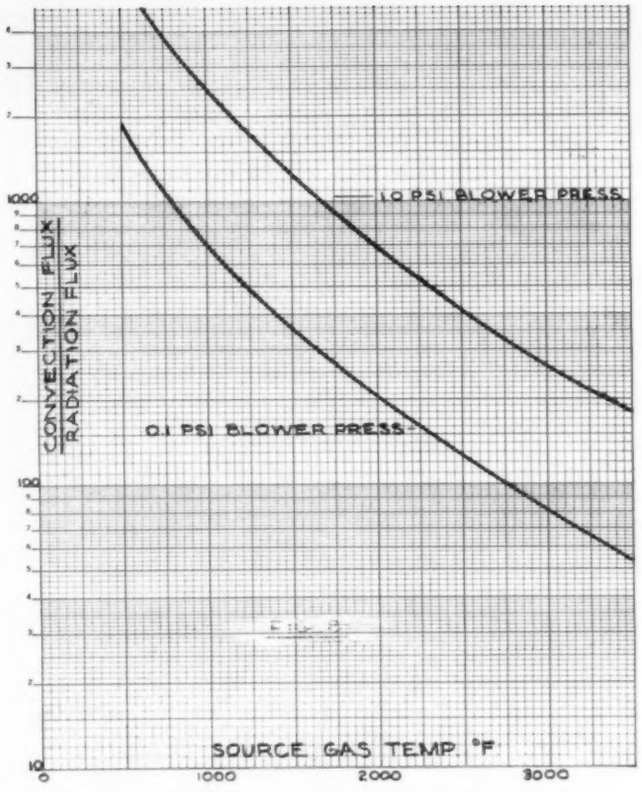


Figure 8 — Curve gives ratio of convection to radiation thermal flux per unit cross section.

does not come free. It takes some energy to push a stream of air even at low velocities. Moreover, when it comes to very long distances, friction losses may be prohibitive. On the other hand, the conditions of the example assumed an emissivity of unity. Practical flames have emissivities often not more than 0.6 which means substantially lower radiant fluxes.

There is another point to be made. Radiation travels in straight lines. It is difficult to take it around corners. In the case of convection, going around a corner involves only a small pressure loss. The net result is that distribution of heat in a desired pattern is usually much more easily accomplished with convection than with radiation. A possible exception is the case when a low energy density over a wide area may be desirable.

THE TRANSFER OF HEAT ACROSS AN INTERFACE

The transportation of heat to a particular location is only part of the problem which we have undertaken to consider. We have already stated that we will also be interested in transferring the heat into a solid surface, for example, a round bar. To discuss this we will introduce the familiar concept of a heat transfer coefficient. It has been empirically established that all cases of convective heat transfer rate across an interface can be represented by an equation of the form:

$$h_c = \frac{Q_c}{A\,(T_g - T_w)} \qquad (4)$$

where Q_c is the convective heat flux across the interface, A is the surface area in sq ft, T_w is the wall temperature and T_g the gas temperature, and h_c is the convective heat transfer coefficient. The convective heat transfer

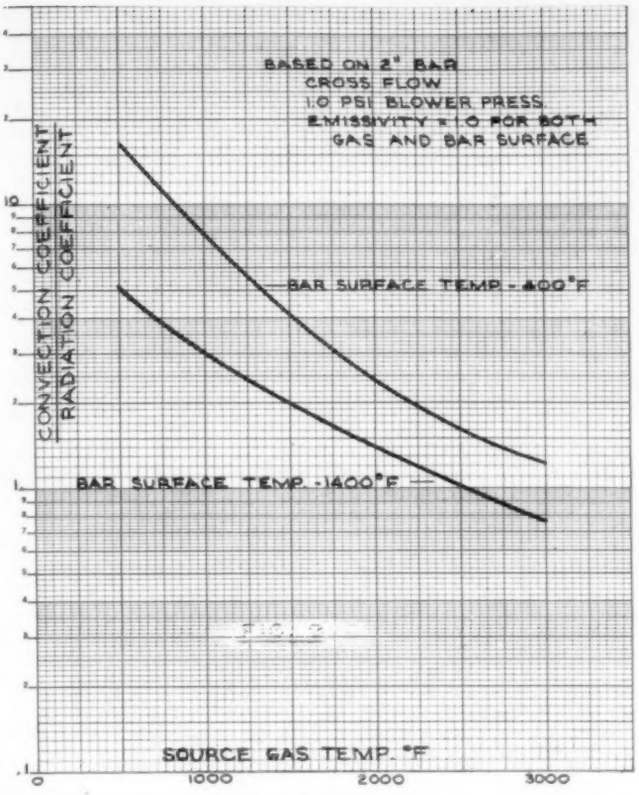


Figure 9 — Curve gives ratio of convection to radiation heat transfer coefficients.

coefficient h_c for flow across a single cylinder may be calculated by the relationship:

$$\frac{h_c\ D_o}{k} = 0.26\ (N_r)^{0.6}\ (N_p)^{0.3} \qquad (5)$$

where D_o is the cylinder diameter, k is the gas film thermal conductivity, N_r the Reynolds number, and N_p the Prandtl number. This coefficient is particularly convenient because, to a good approximation over a wide range, it is independent of the temperature. Its magnitude is determined primarily by the properties of the fluid, the nature (i.e. roughness and aerodynamic shape) of the surface, and the mass velocity of fluid flow relative to the surface. No satisfactory method of calculating a priori the heat transfer coefficient is known. We must depend upon experiment in order to know its magnitude. For the purposes of our comparison we shall consider that our surface is a two-in. diam bar. With the flow velocities which can be obtained using a 1.0 psig blower it turns out that h_c for the case of flow normal to the tube has a conservative value of about 50 Btu per sq ft per degree F per hr. It should be emphasized that this value assumes that all the velocity inherent in a 1.0 psig head is utilixed. This may mean wide departures in design from orthodox furnaces with respect to flow areas. For the purposes of our comparison, however, this is precisely our objective.

Now it would be convenient to establish a radiant transfer coefficient which would be directly comparable with the convective coefficient we have just described. However, as pointed out in equation (1) radiant heat flux is strongly dependent upon absolute temperature level and not simply upon a temperature difference to the first power. Nevertheless, if we are careful, we can define a radiation coefficient which we can compare at a given temperature with a convective coefficient. This will enable us to gain some insight on the relative merits of the two transfer processes when it comes to moving heat across an interface.

If we consider that the surface to which we are transferring heat from a radiating source must at the same time be radiating heat back, we can arrive from equation (1) at an expression for the net flow of heat into the surface by radiation. This turns out to be:

$$Q_r = \tau \epsilon_g \epsilon_w A\ (T_g^4 - T_w^4) \qquad (6)$$

where the symbols have the meanings previously assigned. It is assumed that the combustion gas is the radiating source at the temperature T_g. For simplicity we will also assume that the emissivity of the gas (ϵ_g) and the absorptivity (ϵ_w) of the wall are both unity. We can now define a radiant transfer coefficient by replacing Q_c in equation (4) with the expression for Q_r in equation (6):

$$h_r = \tau \epsilon_g \epsilon_w \frac{(T_g^4 - T_w^4)}{T_g - T_w} \qquad (7)$$

Under given conditions of temperature for gas and wall, h_r can be compared directly with h_c. However, unlike h_c, h_r will vary tremendously with the temperature level as indicated in equation (7).

We can now calculate radiant heat transfer coefficients for various temperatures. We have omitted certain geometry considerations which relate to effective areas of emitter and absorber. We will ignore these except to note that the effective surface area of a round bar "looking" at an emitting flame at some distance is only about half of the peripheral area. The coefficients were calculated on the basis of the entire peripheral area.

The comparison of effective coefficients at various temperatures is shown in Figure 9. Here, we have plotted the ratio of the effective convective transfer coefficient (h_c effective $\cong h_c$) to the effective radiative transfer coefficient (h_r effective $\cong 0.5h_r$). Again we note that except at the very highest temperatures, the effective convective coefficient is better than the radiative one. This conclusion is by no means a new one. However, what we wish to demonstrate is that there is now available a high velocity combustion system which extends to much higher furnace temperatures than before the advantages of convection. Above all, since radiation is generally present as well, we now have a means of obtaining considerable assistance at all temperature levels by the additional use of convection heat transfer. Again it should also be pointed out that the comparison is somewhat oversimplified. We have taken advantage of the maximum coefficient which can be obtained with 1.0 psig air. Lower blower capacities, friction losses, poor flow area design will be expected to lower the ratio.

On the other hand, we have assumed ideal conditions for radiation which will seldom be encountered in practice. Not only must radiation "see" an object to be effective, but the object to be heated must also have an appreciable coefficient of emissivity or else no matter how fast the heat gets there, it is not going to be efficiently absorbed by the object to be heated. Also,

any "blind" spots in the charge are going to result in uneven temperature distribution with the possibility of developing stresses that will distort or even rupture a sensitive metal. This can be avoided to some extent by depending on radiation from the furnace wall or a refractory target to the "blind" side of the charge. However, the wall or target must also see the flame which means that the space required for their "windows" is not always available because of screening by the charge. This leads to large furnace volumes with consequent low gas velocities accompanied by a sacrifice of convective transfer. Convection, can always be made an effective means of heat transfer by properly transporting the gases through any kind of a passage. At the same time convection heat transfer is unconcerned with the absorption qualities of the heat receiver.

In the steel industry, as in other industries, there are many factors which are likely to complicate the problem. For one thing, conditions other than heating may determine the size and shape of our equipment. It is necessary to deal with enclosures of various shapes, with surfaces of varying emissivity and with an extremely wide range of temperatures. It becomes essential, therefore, to carefully study any given process in order to make sure that a high velocity system can and will make a real contribution. If the conditions are right for taking advantage of the very high gas temperatures, their non-radiating qualities and extreme velocities, then one has indeed a most effective new tool for producing a better product at lower costs. If, however, the equipment or process does not lend itself to the proper use of the products of combustion from a high velocity system, then results may have questionable advantage over those obtained from a more conventional system for heating.

APPLICATIONS OF HIGH VELOCITY COMBUSTION TO THE STEEL INDUSTRY

The best basis on which to judge the potential for the use of a high velocity combustion system in the steel industry is to examine some of the applications that have been made or are being contemplated.

Edge heating of skelp — Approximately 1½ years ago an important eastern steel mill found itself limited in the production of continuous butt welded steel pipe due to the inadequacy of the skelp heating furnace. In this furnace 530 Btu per cu ft coke oven gas is burned with air preheated to about 650 F using burners lined up block to block down the length of the furnace. The wall temperatures range from virtually cold at the entrance end to near 3000 F at the exit end. High velocity burners were installed at the high temperature end as shown in cross-section in Figure 10. The burner configuration is shown in Figure 11 and is merely a slight modification of the gas burner previously described to fit certain mounting details of the existing furnace. A full report on the result of this installation has been given before the Philadelphia Section of the AISE (Reference 3). Although less than 10 per cent of the existing burners were replaced with high velocity units, the convection heat transfer from the high velocity products of combustion, being additive to the existing high wall radiation, gave a pronounced edge heating. Greatly improved pipe quality resulted as well as increased tonnage and lower refractory maintenance due to the absence of flame impingement.

This application is typical of a proper use of high velocity combustion. To the writer's knowledge there is no other simple way of propelling gases which are well over 3000 F at more than 100 fps in any ordinary industrial operation.

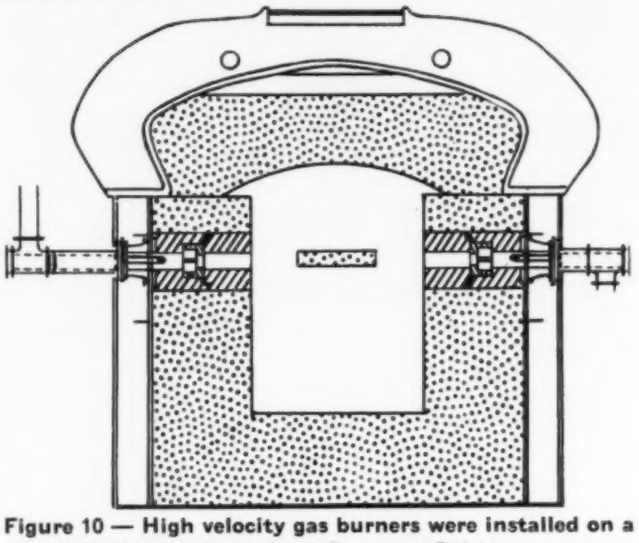


Figure 10 — High velocity gas burners were installed on a skelp heating furnace at Sparrows Point.

Ladle heating — In another session of this convention there will be a discussion of continuous casting as applied to steel. We are happy to have had a high velocity combustion system incorporated as part of this development. In the continuous casting operation it is essential to maintain a constant high temperature in the ladle that is used for pouring the molten metal continuously into the cooled die. Figure 12 shows a high velocity combustor mounted to discharge gases

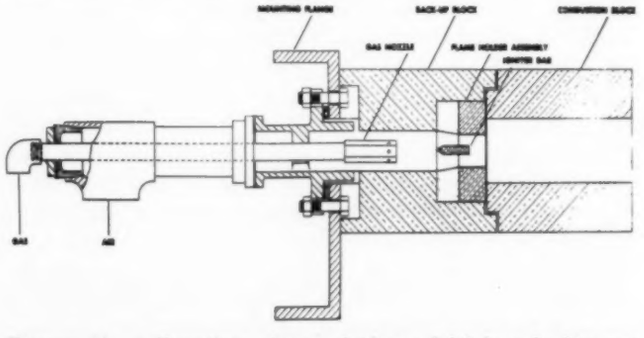


Figure 11 — Drawing shows design of high velocity gas burner for skelp heating furnace.

into an opening in the cover of a large pouring ladle. The burner is mounted so that it can be kept in position even though the ladle is being tilted. The high heat release and turbulence created by the high velocity combustion maintains temperatures in excess of 2800 F during the entire pouring period. The ladles are also preheated by a similar installation before being charged with molten metal. Other applications of this type are successfully operating in Sweden at the plant of Nyby Bruk and at Barrows Steel in Barrows, England. In addition, a new installation is being designed for the Sumitomo Metal Industries in Osaka, Japan.

This application of high velocity combustion suggests

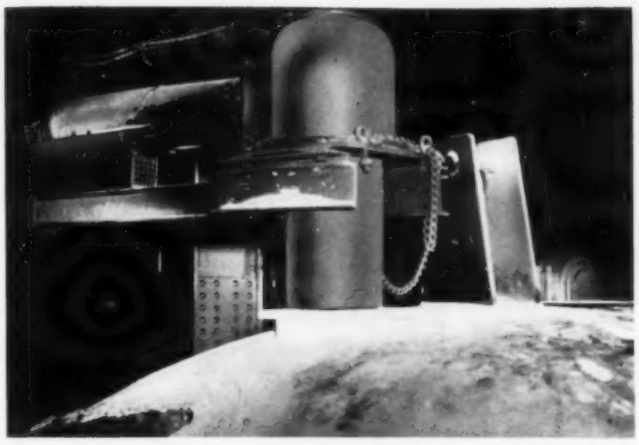
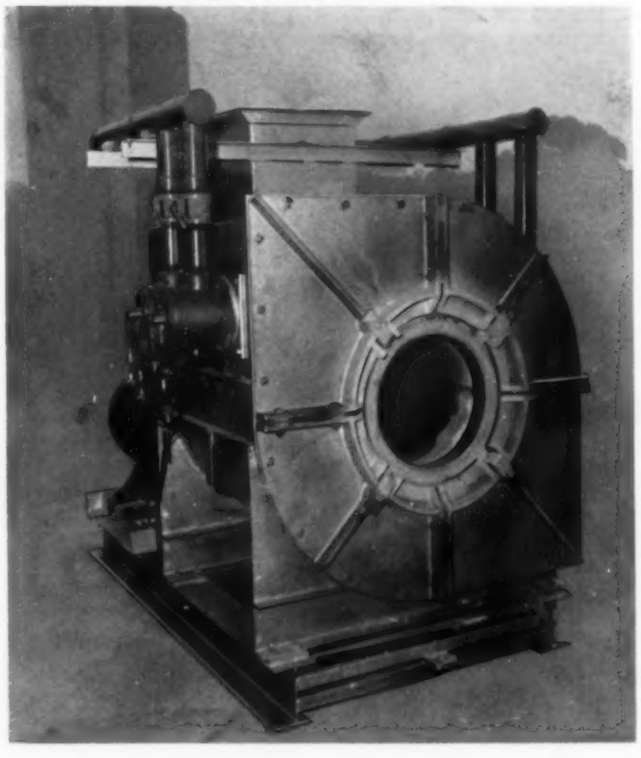


Figure 12 — High velocity burners may also be effective in heating ladles.

the possibilities for melting solid charges in a ladle. The burner mounting would be quite similar to that shown in Figure 12, and an experimental installation is presently being arranged. The foundry industry could make excellent use of this type of operation particularly for alloy casting materials.

Barrel type furnaces — Barrel type furnaces are becoming increasingly recognized as an important type of batch as well as continuous metallurgical furnace. Various style units are being built with varying trade names as given by their manufacturers. Figure 13 shows an installation of high velocity burners to this type of furnace which is used in forging ordnance components. In this arrangement, the burners are fired tangentially to create a rapidly moving and turbulent stream of hot gases within a furnace which can swirl around the charge located in the center. Convection heat transfer with respect to the walls as well as to the charge obviously plays a very important part in this type of furnace

Figure 13 — A number of barrel type furnaces have been designed for high velocity oil burners.



configuration. Another approach which has been made in this type of furnace is to fire the burners radially and allow the hot products of combustion to impinge directly on the work. The latter configuration is more practical when the charge being heated is relatively small in shape. One of the predominant reasons for the success of the barrel type furnace is because the refractory walls can be kept close to the work to minimize heat loss and keep the radiation coefficients high. This, however, requires that a high heat release rate combustion system be utilized since the combustion volume in the furnace proper is extremely small. As with the skelp heating furnace previously described, the convection heat transfer realized in the barrel type furnace augments the radiation transfer from the wall.

A characteristic of the high velocity combustion systems previously described is particularly noticeable and valuable in this type of barrel furnace when utilized at the entering end of a continuous system. This important characteristic is the burner's ability to maintain a high

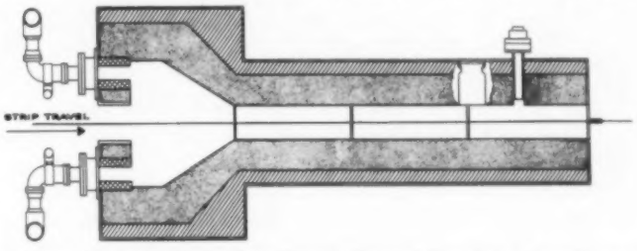


Figure 14 — Strip preheating furnaces provide a good application for high velocity burners.

combustion efficiency without the refractory wall temperature of the furnace necessarily being high. It is most difficult to maintain a high refractory temperature at this portion of a continuous furnace since the steel passing through is absorbing heat at a very rapid rate. This characteristic also allows high tonnage production rates to be possible very quickly after the furnace has been fired. It is not necessary to wait for the refractory walls to reach high temperatures before steel can be started through the furnace.

Strip preheating furnaces — Considerations are currently under way on the installation of a strip preheating furnace which provides another excellent example of the proper utilization of a high velocity combustion system. Such a strip heating furnace would be located immediately ahead of the annealing furnace in a continuous line and the general configuration of such equipment is shown in Figure 14. A furnace of this type is compact because of the lack of combustion volume ordinarily needed in the furnace proper. Another and equally important result is again due to the fact that convection heat transfer plays such an important part in the heat transfer process. The total heat required by the strip is always a function of the convection plus wall radiation. For a given heat input to the metal, the wall radiation temperature can be appreciably lowered where a high degree of convection transfer is possible. This allows the wall temperatures to be maintained at levels which do not present a strip parting problem, particularly in the case of non-ferrous materials should a stoppage of the metal flow occur, due to a breakdown somewhere else in the system.

A factor which is found that is particularly important

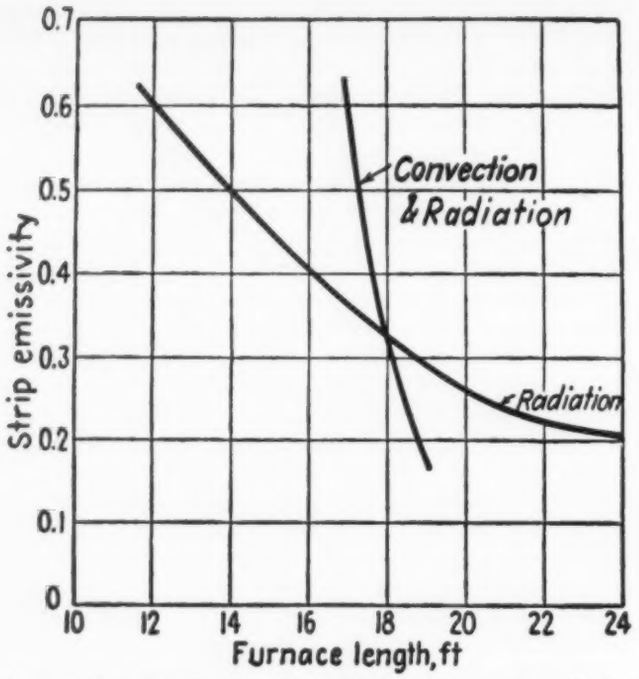


Figure 15 — Curve shows variation in furnace length for heating a given tonnage of strip with various emissivities.

in this type of furnace is the effect of metal emissivity on the heat transfer conditions within the furnace. With a system that is utilizing convection to a high degree, the effect of emissivity is proportionately reduced so that in many cases the approximate tonnage figures can be maintained regardless of changes in surface. Figure 15 is the result of a heat balance that shows that the design conditions affecting furnace length for a given tonnage of strip remain relatively constant regardless of strip emissivity when a system utilizing a large percentage of convection in addition to wall radiation is used. The curve shown is typical only of one set of conditions since a complete representation of this kind of furnace would have to involve a family of curves in which temperatures and mass velocities are also given as parameters.

Radiant or immersion tubes — For applications to radiant or immersion tubes, the high velocity combustion system at once allows a much greater heat input to be utilized due to the high heat release rate obtainable. The fact that the flame is extremely short can be taken advantage of by using the high velocity gas as a means of creating recirculation in tubes designed for this purpose. Work is presently being done in this direction with remarkable results regarding tube temperature uniformity.

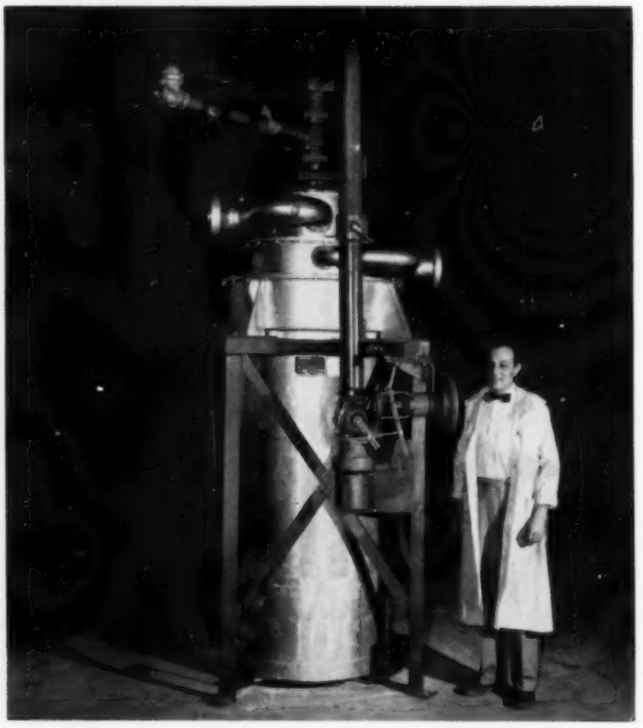
Figure 16 shows an oil fired radiant tube which is capable of radiating well over 3,000,000 Btu per hr. It is fitted with a recuperator at the discharge end so that the combustion air is preheated giving a flame temperature near 4000 F. Strict tube temperature uniformity is not desired in this application which is for melting snow and ice from the wings of parked aircraft. However, as mentioned above, uniformity could be obtained in this unit by utilizing the recirculating system described.

Gas generators and special atmospheres for heat treating — The broad fuel-air-ratio range of the high velocity combustion equipment described provides an excellent means for obtaining desired atmospheres in inert gas generating equipment. In addition, the high heat release rate permits much more compact equipment to be designed. Units have been constructed for this application both for oil and gas firing.

Because of the extremely high heat transfer coefficients obtained from the high velocity products of combustion, very compact and economical designs of gas heat exchangers have been developed. A typical heat exchanger of this type is shown in Figure 17. This particular unit is capable of transferring 2,500,000 Btu per hr and has a normal pressure rating of 300 psi with an outlet temperature of 1200 F. Smaller, as well as lower pressure units have been designed and consideration is under way towards the incorporation of such a unit as a means of heating the inert gas supplied to both continuous and batch annealing furnaces. The metal temperatures in these heat exchangers are generally not more than 100 F higher than the gas tempera-

Figure 16 — A number of radiant tube furnaces use high velocity oil fired burners.

Figure 17 — This heat exchanger is capable of transferring 2,100,000 Btu per hr.



tures which opens a field of high temperature gas heat exchange with the life of the unit no longer being a matter of concern due to metal temperatures. We have operated this type of heat exchanger on air with exit temperatures as high as 1600 F. The fact that such temperatures can be economically obtained makes it practical to think of a heat exchanger as a supplementary or even primary source of heat to a heating operation. An important item is the minimum of heat inertia obtained in this equipment which allows quick and fully controlled cooling cycles to be had without complicating the system with additional equipment.

Finally, for those applications where air mixed with

Figure 18 — High velocity burners on air heaters permit operation at high back pressure levels due to stability of burners.

products of combustion can be used for heating, as in baking wire coatings for drawing purposes, an application of these high velocity burners is shown in Figure 18. Again, here, the high degree of combustion completed within the burner proper allows a great simplification and reduction in physical size of the equipment. The cold or recirculated dilution air can be brought into immediate contact with the products of combustion as they exit from the burner within impairing combustion efficiency. The turbulence from the high velocity promotes quick and efficient mixing, so that in a noticeably simple piece of equipment an air heater design is possible which is independent of the type of fuel being used. The stability of the burners permits this type of unit to be operated at high back pressure levels if necessary.

SUMMARY

The foregoing describes but a few of the many opportunities existing in the steel industry for applying this new high velocity combustion system. It represents a new technique in the field of heat equipment. However, certain special characteristics must be recognized. The products of combustion from this system have far lower radiating qualities than ordinarily encountered with conventional burner equipment and such a source of heat must not be indiscriminately applied to any existing heat equipment. Proper applications to such equipment have yielded excellent results in many cases but care must be taken that the application is consistent with the characteristics of a high velocity system. Properly utilized, this equipment offers a most valuable tool to the steel industry. More will be heard of its achievements in the future.

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3. "*Use of High Velocity Burners for Edge Heating of Skelp*," by Geo. J. Campbell, Assistant Fuel Engineer, Bethlehem Steel Co., Iron and Steel Engineer, October 1954.

DISCUSSION

PRESENTED BY

ANDREW F. KRITSCHER, Assistant Chief-Process Development, National Tube Div., United States Steel Corp., Pittsburgh, Pa.

FRED S. BLOOM, President, Bloom Engineering Co., Pittsburgh, Pa.

HAROLD V. FLAGG, Combustion Engineer, Armco Steel Corp., Middletown, Ohio

R. J. REED, Application Engineer, The North American Manufacturing Co., Cleveland, Ohio

LEONARD C. PESKIN, President, Thermal Research and Engineering Corp., Conshohocken, Pa.

Andrew F. Kritscher: As summarized at the end of the paper, a new tool is offered to the steel engineers. It will have to be used judiciously in the right applications and there certainly should be some benefits by the proper application of these principles.

Fred S. Bloom: Mr. Peskin has presented a very interesting approach to a new combustion system. We know in industry that there are certain applications where fast combustion conditions would be advantageous. However, from a normal application of a combustion system, there is no need for combustion speed or thermal release in the ranges of 1,000,000 Btu per cu ft of combustion volume per hr. Usually, the furnace volume is more than ample to use a conventional combustion or burner system. My own company manufactures burners which have the ability to burn large quantities of fuel per hour in a very limited space. It is our thinking that the application of this burner must be judicially used and it is not a general purpose combustion system. Some types of fuel application are ideal for burners of this type. Others are not.

Mr. Peskin has described reasons why his type of burner and combustion system have merit over other types of heat applications. He has propounded the theory that high velocity convective heat transfer can improve the speed of heating steel in a high temperature furnace. We do not disagree with the theoretical approach that has been stated, but we wonder whether theory and practice can be substantiated. It would be interesting to see the increased speed of heating which Mr. Perskin claims can be obtained.

I hope Mr. Peskin can show us some actual test data to demonstrate that his approach in applying heat is better than what can be obtained in a normal high temperature furnace. I would like to ask Mr. Peskin to furnish us a heating curve on a specific size piece of steel to demonstrate that convective heat can be used to advantage in a high temperature furnace. It is my

thought that any improvement that is obtained with Mr. Peskin's combustion system is accomplished by increasing furnace temperature and not by convective heat transfer.

I cannot see how convective heat transfer can be used in many applications in the steel industry. If Mr. Peskin has test data, it would certainly be very interesting to compare this with test data which is available using heat transfer based on normal steel mill furnace conditions.

Harold V. Flagg: For a furnace system at 1800 F or 2000 F, is there any possibility of building a burner for No. 6 fuel oil that will work down to two gallons of oil an hour?

R. J. Reed: In applications such as the Fretz-Moon skelp heating furnace which you mentioned, what difference does it make whether the 3000 F stream of hot gases impinging on the edge of the strip is entirely products of completed combustion or the tip of a flame as long as both have the same temperature and velocity? A considerably better heat transfer rate results from actual flame contact. See J. K. Kilham's paper, "Energy Transfer from Flame Gases to Solids"; page 733 of Third Symposium on Combustion Flame and Explosion Phenomena. Might this not compensate for the slight reduction in direct heat transfer due to flame radiation to the surroundings?

The velocity corresponding to one psi blower pressure is:

$$\sqrt{\frac{2g\,(\Delta P)}{\rho}} = \sqrt{\frac{2\left(32.2\,\frac{\text{ft}}{\text{sec}^2}\right)(1\text{ lb/in.}^2)\left(\frac{144\text{ lb/ft}^2}{1\text{ lb/in.}^2}\right)}{0.0763\text{ lb/ft}^3}} =$$

349 fps

Will not all large port nozzle mixing burners produce approximately this same velocity when supplied with air at one psi at the burner? Also, the convection heat transfer rates mentioned would only be possible with considerable pressure loss across the pieces being heated (due to close spacing of the pieces and narrow passages); so would not this reduce the pressure drop across the burner (for the same blower pressure) and thereby cut the nozzle velocity to less than that obtained in a furnace designed for radiant heat transfer?

Everyone will agree with the author when he says that convection heating will do best in a furnace designed for that purpose. Similarly, radiant heating is best accomplished in furnaces designed for it. When comparing convection and radiation heat transfer coefficients, should not you consider each under the conditions in which it would be used, rather than convection coefficients in convection furnaces vs radiation coefficients in convection furnaces?

Leonard C. Peskin: In answer to Mr. Bloom, I regret that our organization is still too young to provide him at this meeting with the precise form of data which he has requested. However, some very recently published information describing the use of high velocity burners in practical steel mill applications definitely demonstrates the error of his conclusions. I refer to the paper by G. J. Campbell on "The Use of High Velocity Burners for Edge Heating Skelp" Printed in Iron and Steel Engineer, October 1954. In this paper is described a high temperature furnace designed in accordance with principles laid down years ago in which substitution of only 26 burners of the high velocity type out of a total of 356 burners has resulted not only in important production increases, but also improvements in quality and maintenance costs. I refer him also to a recently publicized description of a slab heating furnace at Atlas Steels Limited in Welland, Ontario where high velocity burners have resulted in ususual heat transfer rates at the entering end of a furnace where conventional burners are known to exhibit poor heating characteristics due to the deleterious effect of the cold charge on the combustion process.

In our somewhat limited experience we have yet to find a conventional design of furnace that is not at once improved in its performance by the use of high velocity burners. However, this is not to say that such furnaces will not present problems when forced to operate with a high velocity type of combustion system. For example, if such a structure is not gas tight, it is only logical to predict that high velocity streams of hot gas entering such a furnace may cause leakage problems not experienced with conventional burners. In some old designs there may be other types of problems associated with the unusually high speed flow of gases. However, none of these are incapable of solution even in the most orthodox designs. Obviously, the very best application of a high velocity combustion system is that which can be made to a furnace specifically designed to take advantage of the high velocity flow of gas and therefore take advantage of the beneficial heat transfer component produced by convection in addition to the usual radiation. Contrary to Mr. Bloom's remarks, the unusual variety of applications already found for the high velocity combustion system ranging in the steel industry from ladle heating to slab furnaces would definitely seem to indicate that a general purpose combustion system has been developed. Finally, if in a so-called normal application of a combustion system as referred to by Mr. Bloom, there is no interest on the part of the user to improve his operations and he is satisfied to continue with existing performance, then certainly there is no need for change. However, the use of high velocity combustion which as quoted in the previously mentioned paper by Mr. Campbell offers "a new approach to heating problems not necessarily limited to the butt-weld process."

In answer to Mr. Flagg's question, it is possible to provide a turn-down for this type of burner utilizing heavy oil that will be as much as 10 to 1. Normal turn-down for our high velocity oil burners is usually kept to a ratio of 4 to 1. Unfortunately, up to this time, our work on heavy oil high velocity combustion has been limited to the larger sizes of burners starting at approximately 10,000,000 Btu per hr. This is largely due to the fact that much of our work has been financed by the government and is being directed towards the development of single burner units with capacities as high as 60,000,000 Btu per hr. We are, however, now proceeding on our own to manufacture small sizes and have succeeded in burning such heavy fuel in a unit with a maximum output of 1,000,000 Btu per hr. This unit should be capable of turning down to the output you have mentioned. It is a difficult job to make these burners very small when you consider that in a single package it is necessary to provide not only all of the

requirements with respect to mixing and burning, but also do the necessary vaporizing all within the dimensions of a practical piece of equipment. However, the output you require is entirely possible with No. 6 oil and should be available in the very near future.

In answer to the questions raised by Mr. Reed, we have the following to say; There are two parts to this question and we would like to comment as follows: The answer to the first part is that there would be no difference, at least no appreciable one in the convective transfer from partly burned or completely burned combustion products so long as the temperatures and velocities are the same. The point is that it would be difficult to get full velocity and temperature in unburned products because it is the energy from combustion which achieves the velocity and temperature. Thus, if actual flame is contacting the skelp in the free space of the furnace, it is implied that at least some of the energy is being released in relatively unconfined space. This means that the maximum velocity would not be reached.

The second part of the question is not entirely clear, for our reading of Kilham's article indicates that forced convection and radiation are responsible for most if not all of the heat transfer from flames with forced convection contributing a major part of the energy to a freely radiating solid immersed therein, at least in the case of a carbon monoxide flame. If there is any effect due to radical combination on the solid surface, it appears that these effects are comparatively slight. It would appear, therefore, that we are once more back to heat transfer by convection and radiation from gases regardless of whether we are dealing with partly burned or completely burned combustion products. Incidentally, we note with interest that Kilham's observed convective coefficients agree very nicely with those calculated from the usual empirical relationships such as we commonly use in our work.

The velocity of 349 fps which Mr. Reed calculates is entirely correct for the case of cold air (density 0.0763). If the burned gas density (say one-ninth of 0.0763) is put into the equation, the velocity comes out in the neighborhood of 1000 or so fps which we figure is possible with one psi air. If the one psi drop is taken across a nozzle with the cold air which relatively speaking may be the case with "all large port nozzle mixing burners" then, of course, 349 fps is the velocity which would be reached by these gases. In our burner, the one psi drop can be taken by the burned gas after combustion, that is, when the density is low. This latter is what permits the high velocities to be reached compared to orthodox systems in which the energy is released in relatively unconfined free space. What we are implying is that most ordinary burners take the pressure drop available from the blower when the gas is comparatively cold, that is, before combustion is anywhere near completed.

To be sure, there will be pressure losses from convection across surfaces to be heated. No attempt was made to allow for these in the idealized case presented in the paper, just as no attempt was made to allow for low emissivities and flame temperatures in the radiative case. If the furnace is so designed that pressure drop after the burner nozzle has the effect of reducing the drop across the burner, then obviously the velocity at the burner exit will be decreased. This really makes no difference, however, because the velocity will be achieved wherever the pressure drop is taken. If the pressure drop is across the surfaces to be heated then the velocity will appear there. We do not see the point in saying that the nozzle velocity would be less than that obtained in a furnace designed for radiant heat transfer. What good would velocity do in such a case, anyway?

On Mr. Reed's last question, the coefficients presented in my paper in each case related to idealized conditions and had nothing to do with any particular furnace or furnace type. They were merely supposed to indicate what might be achieved by the best designs in either case. Certainly in making any comparison, one should stick to comparable conditions. Of course, you must realize that there are never any absolutes in practical furnaces. In any convection furnace there must always be some radiation, at least due to surfaces coming in contact with the flowing gases. Likewise, since there is flow there will always be some convection in a radiation furnace. It is a question of degree. In dealing with high temperatures, one can build a convection furnace utilizing high velocity burners and still make use of radiating surfaces. On the other hand, by virtue of geometry alone, one can build a radiation furnace and be left with relatively unimportant convection heat transfer.

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Saturday, May 21, 1955 — Annual Picnic

Pearl Lake, Birmingham, Ala.

ST. LOUIS SECTION

Wednesday, May 18, 1955 — 6:30 P.M.

Inspection trip to Laclede Steel Co.; Alton, Ill. Includes Dinner at Plant.

SAN FRANCISCO SECTION

Tuesday, May 3, 1955 — Social Hour 6:00 P.M., Dinner 7:00 P.M., Meeting 8:00 P.M.

"General Aspects of Oxygen Converter Process of Making Steel," by J. W. Irvin, Associate Engineer, Kaiser Engineers, Inc., Oakland, Calif.

Villa de la Paix Restaurant, Oakland, Calif.

YOUNGSTOWN SECTION

Monday, May 23, 1955

Inspection trip to the Mullins Manufacturing Co., Salem, Ohio

AISE PICTORIAL REVIEW

Western Meeting

San Francisco, California

March 21, 22, 23, 1955

A total of 491 men registered at the second AISE Western meeting held in the St. Francis Hotel (1). Of these, 283 came from the San Francisco area, and the remainder was fairly evenly split between east of the Mississippi and other western areas. Speakers and chairmen of the afternoon session on Monday, March 21, are shown planning the program (2) for their meeting. From left to right are G. A. Moudry, James MacGregor, William A. Perry, E. F. Donatic (chairman), E. C. Thomas (chairman) and V. W. Johnson. Stoking up for the morning session (3) on Monday at the authors' breakfast can be seen (sitting) N. L. Bock and W. A. Marshall (chairmen) and David Lyle. Standing are A. J. Winchester, Jr., F. C. Schoen and W. E. Van Horne. Shown in the usual order are the participants for the afternoon session on Tuesday (4), W. F. Pruden (chairman), S. L. Jameson, H. L. Richardson and Jack B. Klukkert, (standing) Ruben Finkelstein (chairman), W. L. Murphy (standing) and G. W. Teskey. The morning session on Tuesday saw on its program (5) Frank Nicholson, F. W. Rys, G. B. McMeans (chairman), John W. Fox and C. F. Hauck. Technical sessions (6) were well attended. At a committee meeting held on Monday night (7), leaders of the western section decided to recommend to the AISE Board of Directors that the western section be split into two sections, one in Los Angeles and one in San Francisco.

Outstanding steel executives (8) were present at the informal stag dinner. Shown sitting are John H. Vohr, president AISE and also general superintendent, United States Steel's Gary works and H. H. Fuller, president of Bethlehem Pacific Coast Steel Corp. Standing are Joseph Eastman, Jr., president, Pacific States Steel Corp., Laurence S. Dahl, vice president of operations, Columbia-Geneva Steel Div., United States Steel Corp. and George B. McMeans, vice president of operations, Kaiser Steel Corp. Spark plugs (9) in the development of the AISE Western section have been E. F. Donatic of Kaiser Steel Corp., W. F. Pruden and W. A. Marshall of the Columbia-Geneva Div. of United States Steel Corp. Two long-time and loyal members of the AISE (10) met again in San Francisco. At left is Wilfred Sykes, former president of the Inland Steel Co., now retired and living on the west coast, who remembered giving a paper at an AISE meeting in 1909. He is seen talking to William A. Perry, assistant general superintendent — service, Inland Steel Co. who presented a paper at this western meeting. W. J. McClung, vice president, steel plants, Bethlehem Pacific Coast Steel Corp., and J. L. Ashby, vice president, Kaiser Steel Corp. (11), were guests at the speaker's table. The informal stag dinner (12) was very well attended with about 450 present. The third day of the meeting was devoted to an inspection trip to the Pittsburgh Works of the Columbia-Geneva Steel Div. of the United States Steel Corp. The photograph (13) shows buses waiting for late breakfasters.

Progress in Power Generation from Atomic Energy

By R. G. LORRAINE

Atomic Products Div., Atomic Power Study*, General Electric Co., Schenectady, N. Y.

. . . . atomic power will become a reality in the near future if for no other reason than coal, gas and oil will be insufficient to satisfy power demand . . . . development and research will reduce present estimated costs . . . . it is strongly recommended that industry interested in various phases of the subject should join in the study groups under contract with the AEC in order to obtain accurate available information which they will need for participation in the program . . . .

▲ TO those who are awaiting the fulfillment of the various predictions which have been made for the applications of atomic power in industry, it may seem that progress is slow — that there is a great deal of talk about peaceful uses of atomic energy, but few practical applications to show for all the work which has been done. To those who are working in this field every day, the rate of progress appears quite rapid in view of the large number of diverse considerations that must be explored to achieve each step of progress.

Perhaps we would not say so much about what we are doing, and what we think we can do, if it were not for the very great interest shown by all segments of industry in the development of atomic power. This interest is good — it stimulates progress; it indicates wide-spread realization of the inherent potential of atomic power to contribute in varying degrees to most segments of our industrial economy.

The continued operation and expansion of modern industrial society depends upon ever larger supplies of energy. We have been living high off the accumulated stored energy in the best of the coal, oil and gas reserves. Rates of extraction have been large. The cost of finding and exploiting new reserves is going up. While the efficiency of use has continually increased further increases will be harder to achieve. Consequently, atomic energy, which offers a manyfold increase in energy reserves, is of great interest. The aggregate heat production from estimated amounts of uranium recoverable at less than $100 per lb is over 25 times the heat content of the known reserves of fossil fuels, and undoubtedly substantial amounts at a fraction of this cost. The harnessing of atomic energy to our use offers the best prospects for continuing our expanding industrial development.

This last year has been marked by a number of important developments. The principal of these are:

1. The new atomic energy act.
2. Improvement in estimated economy of atomic electric generating plants.
3. A.E.C. industrial power reactor development program.
4. Army packaged reactor program.
5. Growth of study teams.

These developments are indicative of an increased effort on the part of the A.E.C. to enlarge the participation of industry in atomic power development and a consequent quickening of interest on the part of industry in how they may share in the development.

THE NEW ATOMIC ENERGY ACT

The new atomic energy act, which became effective August 30, 1954, has the objective of increasing industrial participation in making atomic energy available for peace-time use. Under the previous act, the government had an absolute monopoly in atomic matters. It was illegal for anyone other than the Atomic Energy Commission to own fissionable material or source material from which fissionable material is derived — such as plutonium and uranium. It was illegal to build, own and operate apparatus utilizing and producing fissionable materials such as a reactor. The only way in which private enterprise could take part in the atomic energy business was by contract with the government. Its scope of activity was limited by the government's objectives. The commission was permitted and did use

*Footnote: The Atomic Power Study operates under an industrial study agreement with the Atomic Energy Commission.

industrial organizations to execute many of its programs of development and research and to operate its production facilities.

The new law allows private ownership of production and utilization facilities, subject to licensing by the commission. It empowers the A.E.C. to lease to private persons or corporations source and fissionable material and to recall this material paying fair compensation for the private operator's losses. Private companies can produce such special nuclear material, subject to control by the A.E.C. for public health and national safety reasons. The field within which private industry can secure patents is enlarged, but compulsory licensing for a period of five years is required to prevent monopoly and all patents conceived under any contract or arrangement with the commission are the property of the commission. New standards of safety protection are set up in the new law for the purpose of having these consistent with procedures used in private industry. Security regulations have been changed to enlarge the flow of information between groups in this country and between U.S. and foreign organizations under implementing rules and regulations of the commission.

The new act requires licensing for every phase of private industry activity which might be engaged in under the act except for activities engaged in under contract with the commission or department of defense. Licenses will be required for:

1. Distribution of source material.
2. Transfer of source material in interstate commerce.
3. Receipt or production and transfer of special nuclear material.
4. Manufacture of specially designed components.
5. Construction of facilities.
6. To develop and operate experimental utilization and production facilities to demonstrate their practical value.
7. Operation of utilization and production facilities.

The terms and conditions contained in such licenses will be determined by the commission.

Thus the new act, fundamentally, permits, but does not require, the commission to set up such rules, regulations, and procedures to enable private business to enter the atomic field, and it provides that such activities of private business shall be under tight government control. It provides limited incentives and opportunities for private business which appear to be sufficient to justify industry increasing its technical effort in atomic energy and assuming the business risks associated with such a pioneering development.

ECONOMIC IMPROVEMENT OF ATOMIC POWER PLANTS

The second important aspect of progress in atomic power is concerned with economic competition of atomic power plants with conventional plants in the industrial field. It is generally agreed that atomic energy must come into increasing use as our supplies of conventional fuels approach the point of exhaustion. The reserves of conventional fuels are variously estimated to be sufficient for our expanding industry for 50 to several hundred years. During this time, the difficulty of extraction is expected to gradually increase their cost. From this standpoint, atomic energy use can be a long-term development.

However, it is desirable to conserve conventional fuels for uses such as raw material for chemical derivatives for which atomic energy appears to be unsuited. In addition, if atomic energy can be used competitively in the production of power, a broader base is developed for expanding our industrial development and common welfare, and strengthening our national defense. Thus, there are good reasons for achieving economic use promptly.

The major industrial use appears to be in the generation of electric energy in central station type plants such as are operated by electric utility companies. There are other prospective industrial uses where relatively large and constant electrical and process heat loads exist. In the electro-chemical industry, the aluminum reduction plant is an example of such an electrical load. There are longer range possibilities in air, sea and railroad transportation. There is, of course, the parallel large development of military weapons, propulsion plants for air and sea craft and packaged power plants which is outside of our subject of industrial power progress but, nevertheless, contributes heavily to its progress.

TABLE I

Year	Added generating capacity, millions of kw per yr	Total generating capacity, millions of kw
1955	....	102
1965	12.5	195
1970	16.5	270
1975	18.5	358
1980	20.0	455

In order to assess the progress required for atomic electric generating plants to compete with conventional plants, a brief review of the economics of conventional plants is necessary. The growth of new plant is rapid. An average of the Edison Electric Institute estimates of yearly additions of generating capacity and total generating capability during the next 25 years is shown in Table I. Generating capability is doubling in a little more than every ten years. This means that the proportion of plants that have attained half their expected life is small and that the cost of generating electric energy is largely determined by the newer plants. The use of new plants as base load plants, because of their higher efficiency, also contributes to their large effect on system generating cost.

The overall generating efficiency of electric plants has consistently improved over the years and may be expected to continue to do so. New plants at the present time average about 9300 Btu per kwhr and there are plants in the design stage having estimated efficiencies of about 8500 Btu per kwhr. It is expected that plant efficiencies as low as 8200 Btu will be obtained by 1965 and 7700 Btu per kwhr by 1975. Achievement of these higher efficiencies may increase the cost of high temperature parts of the plant, but it can be expected that design improvements throughout the plant will offset these cost increases. Thus, the cost per kw of capability will not change appreciably.

According to the Federal Power Commission regions, the 1952 costs per kwhr in large new post-war steam plants fall in the following ranges:

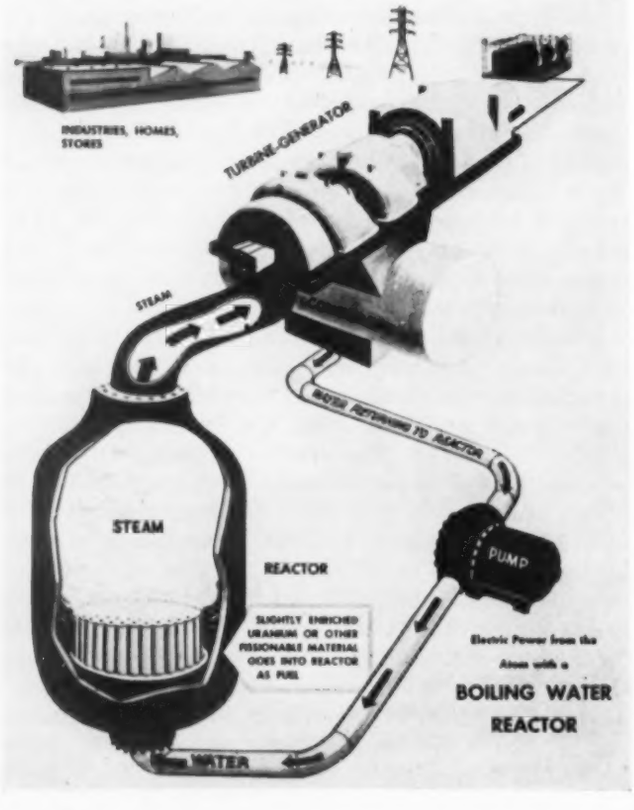
Northeast	5½-8½ mills
East Central	4 -7 mills
Southeast	3½-8½ mills
North Central	5 -7½ mills
South Central	2½-5½ mills
West Central	4½-6 mills
Northwest	4 -6½ mills
Southwest	5½-7 mills

If an atomic generating plant is to compete economically with a conventional steam plant, it must at least match the generating cost per kwhr of the conventional plant that it would replace. In view of the downward trend in conventional energy costs for new plants, it is evident that atomic plants must do much better than the high figure of kwhr costs in the preceding table and perhaps approach the low figure to be competitive in each region.

The costs of electric power generation may for convenience be considered to be made up of fixed charges, operating costs (exclusive of fuel) and fuel costs. The fixed charges depend upon the capital investment in the plant and the fixed charge rate. A comparison of the estimated capital investment of an atomic electric generating plant, obtained in connection with a recent study by our company's Atomic Power Study, will serve to illustrate the differences in plant investment cost of atomic and conventional plants and indicate the areas where reductions in atomic plant costs are important. The atomic plant has a reactor which we have called a tank type water-moderated boiling reactor.

It is our feeling that this type of plant has good prospects for early development to the point of competing with conventional plants. Figure 1 shows the essential elements. The reactor consists primarily of a tank of water under moderate pressure in which the fuel elements are suspended in a geometric pattern.

Figure 1 — The boiling water reactor consists primarily of a tank of water under moderate pressure on which the fuel elements are suspended in a geometrical pattern.



Since steam, generated in the reactor, is used by the turbine, there is no intermediate heat exchanger between the reactor and the steam generator, thus, one heat transfer loop with its pumps, valves and piping is eliminated. For the same thermal cycle efficiency, the pressure is about one-fourth as great as would be required in a pressurized water reactor to produce the same steam pressure at the turbine. The circulating pumps are about one-fifth the size that would be required if boiling did not take place in the reactor. Also, the fuel element is at a more conservative temperature and the pressure vessel has thinner walls.

As radioactive steam goes through the turbine and after condensation back through the feedwater system to the reactor, it is probable that radioactive contaminants would remain in the turbine, condenser and feedwater system and might be expected to make maintenance difficult. Calculation, based on corrosion rates of reactor materials, indicate that activities which will be encountered should not exceed a few milli-Roentgens per hr, and would be of little biological significance.

The thermal efficiency of a boiling reactor plant with 600-psi pressure in the reactor vessel is, of course, low by conventional power plant standards. Estimates indicate that 12,700 Btu per kwhr is obtainable after providing power to operate the plant auxiliaries.

The plant investment, not including development, is presently much higher than conventional plants running $225 per kw to $450 per kw, taking into account size variation and other things. Conventional plants, coal fired, are about $145 per kw in large sizes. However, there are good prospects that atomic plants following the first few will have much lower costs.

The higher capital costs of the atomic plant arise for a number of reasons. The reactor is structurally complex and of expensive materials. It requires a large, heavy shield. Its instrumentation and control and provisions for loading and unloading fuel are new designs and not generally production line components. The plant must maintain control of radioactive wastes through ventilation and storage. The thermal efficiency being lower than for comparable conventional plants, a larger heat capacity and, hence, larger reactor, condenser and feedwater system are required. The auxiliary power supply must be of a very high order of reliability to insure that the heat which continues to be released after shutdown of the reactor can be disposed of. Security, safety and fuel accountability provisions add to the cost.

It is our belief that succeeding plants of this type will show continual technological improvement. It is expected that the reactor structure can be greatly simplified and lower cost materials used. The same comment applies to the piping system and ventilation. The pressure enclosure in the present design provides a means of controlling radioactive gases and particles in the event of their release during maloperation. While this is highly improbable, it is good judgment to provide this protection until operating experience and technical improvements indicate that it is an unnecessary precaution. If these things can be accomplished, Table II shows the reduction which may be possible in, say, 25 years. Atomic and conventional plant investment costs will then be about a standoff.

A word of caution should be injected here with regard

TABLE II

Plant Investment
Per Cent of Present Design Total Investment

Item	Present design of atomic plant, per cent	Possible improved atomic plant, per cent
Reactor, accessories and shielding	21	9
Turbine, generator and auxiliaries	19	19
Electrical equipment and auxiliary power system	14	8
Feedwater and piping systems	13	9
Fuel and waste handling systems	3	3
Building	19	10
Land and land improvement	4	3
Engineering and field supervision	7	6
Total	100	67

to taking the results of paper study estimates as accomplished fact. Until a reactor plant is actually built and operated, its estimated cost and those for similar plants should not be considered to be on a firm basis. While considerable thought and design is back of such estimates and an effort is made to allow properly for things that are not fully developed, there is the possibility that certain assumptions are incorrect, that development will be more extensive and costly than anticipated and that the contributing technology will not advance as expected. With all of these possible shortcomings, such estimates are, however, valuable as an aid in planning for the future. There are many knowledgable people engaged in reactor plant work who share the view that such estimates will in the main be realized and possibly exceeded.

The second element of electric power cost is operating expense other than fuel. Modern, conventional generating plants operated on base load have an average operating expense less fuel of about 0.5 mills per kwhr. An atomic plant will probably be higher. The presence of radioactivity in the steam, feedwater and waste handling system will increase maintenance costs. The number of plant guards required will be increased. There is no counterpart in a conventional plant for the radioactivity monitoring and methods people. It is estimated that the total effect of these differences adds 0.1 to 0.4 mills per kwhr to the operating cost, making 0.6 to 0.9 mills per kwhr for the atomic plant.

The remaining element of electrical power cost is fuel. Atomic fuel differs in many respects from conventional fuels. The energy per pound is enormous. Table III shows the energy released by converting matter to energy. When fission takes place, about one one-thousandth of the mass of the nucleus of the atom is converted to energy. Incidently, only a very small part of the energy released is electrical, the beta decay energy is shown in Table IV, and there is no known way of collecting it efficiently. Uranium and thorium are the "source materials" for nuclear reactors as defined in the atomic energy act.

TABLE III

Mass Energy Relation

$E = MC^2$
E = energy
M = mass
C = velocity of light or 982,000,000 ft per sec

This means that:

One gram equals	One pound equals
900,000,000,000,000,000,000 ergs	39,000,000,000,000 Btu
1,000 megawatt days (MWD)	450,000 megawatt days (MWD)
24,000,000 kwhr	11,400,000,000 kwhr

When fission takes place, the number of neutrons released is "considerably greater than two," according to A.E.C. released information. In a chain reaction, one neutron is always used up in producing a new fission. The remaining neutron or neutrons are available for the production of new fuel, plutonium from uranium — 238 or uranium — 233 from thorium. The reactor of our example uses uranium as a fuel. The uranium is slightly enriched; that is, there is more of the fissionable isotope uranium — 235, than is present in natural uranium. Such enriched fuel, as well as plutonium and uranium — 233 or other materials such as the commission may so classify, are defined as "special nuclear materials" by the atomic energy act. Enrichment of the fuel is necessary to make the chain reaction take place in the reactor being discussed because structural materials, the water in the core, and impurities present extract neutrons from the process and reduce the neutron economy.

TABLE IV

Energy Division of U-235 Fission

Available directly as heat		
Kinetic energy of fission fragments	0.83	
Kinetic energy of fission neutrons	0.03	
Instantaneous gamma energy	0.03	
		0.89
Delayed heat available from fission products		
Beta decay energy	0.03	
Gamma decay energy	0.03	
		0.06
Lost to penetrating radiations		0.05
Total		1.00

In a slightly enriched reactor, some new fuel is produced from the uranium 238 in the fuel charge, but not at as fast a rate as the uranium — 235 is consumed. This new made fuel is also consumed in part. However, the total number of fissionable atoms will gradually decrease during operation since less new fuel is made than is destroyed. One limit on the amount of power which can be generated, before refueling the reactor, is set by this gradual reduction of the amount of fuel present combined with the accumulation of fission products which reduce the neutron economy of the process.

Another limit is the result of the transmutation of atoms of fuel to other elements, collectively called fission products. This transmutation is accompanied by relatively large changes in the dimensions of the fuel element. There were ways developed for inhibiting this irradiation damage as early as 1951. This work is continuing throughout the A.E.C.'s laboratories, as the development of fuels which will withstand large amounts of irradiation is important; extending, as it does, the power obtained from the fuel during its period in the reactor. It is expected that fuels will be developed which

will permit operation to 10,000 megawatt days per ton. This corresponds to burning-up about one per cent of all the atoms of fuel present.

It seems reasonable to expect that long burn-up fuels will be available in a few years and proven in a few years after that. Many expects, who have been working on the problem, feel confident that a solution will be found. Furthermore, there appears to be a number of ways of reaching the desired goal.

The cost of long burn-up fuel for a reactor depends upon the charges set up by the commission under the fuel license for the particular composition of special material required. A classified schedule of charges was recently announced by the A. E. C. By assuming 10,000 megawatt days per ton burn-up, the natural uranium and enrichment cost remaining at about the levels used in previous illustrations in the open literature, it is possible to determine for illustration an approximate licensing charge. To this must be added the cost of fabricating the fuel. On this basis, the fuel cost estimate can be relatively low; about1.2 to 3.0 mills per kwhr. If reprocessing costs of spent fuels can be reduced, then the fuel cost could be still lower. If costs, such as 1.2 to 1.5 mills per kwhr, are realized; then atomic energy power plants, like the one of our example, might be competitive with conventional plants or very close to becoming so, in high cost fuel areas of the country. Table V, shows the resulting electric power cost spread for the ranges of fixed charges, operating and fuel costs discussed.

TABLE V

Electric Power Cost
Atomic Electric Plant
Long Burn-up Fuel, 0.8 Load Factor

	Mills per kwhr
Fixed charges	4.4- 8.8
Operating costs	0.6- 0.9
Fuel	1.2- 3.0
Total	6.2-12.7

It is our belief, based upon such information as we can obtain, that there are no known forces that would cause a radical rise in the cost of uranium. Jesse C. Johnson, A.E.C.'s raw materials director, said recently "There is no doubt about having sufficient nuclear fuel for the future power industry." Visualizing a time when atomic plant capacity reaches 100,000,000 kw and new capacity is being added at the rate of 15,000,000 kw per year, "These assumptions indicate a world commercial market for uranium metal of about 14,000 tons a year . . . " ". . . roughly equivalent to 17,000 tons of uranium oxide (U_3O_8). On the basis of our present knowledge of free world uranium resources, a production rate of 17,000 tons (U_3O_8) or even more should be available at a price of not more than $10 a lb . . . For the more distant future, there are vast uranium reserves in low grade phosphate and shale deposits, where the cost of the uranium may be from $30 to $50 per lb."

The A.E.C. and others interested in atomic power development have made forecasts of when atomic power plants will become economic in fringe areas and then expand to general use in the generation of electricity. The time of entry and the rate of growth are very sensitive to small variations in the cost factors. As has been pointed out, these cost factors are considerably more uncertain than for a conventional steam plant. As an indication of the uncertainty introduced by the cost factors, some recent estimates which we have made of the per cent of atomic generation in service in 1980, may be of interest. The bar on the left in Figure 2 shows the per cent of nuclear generation that will be installed if optimistic estimates of first cost and fuel cost are achieved. The bar on the right is obtained if one is pessimistic about both. The two middle bars result from a pessimistic first cost assumption coupled with an optimistic fuel cost assumption and conversely. In developing these estimates, a modest improvement in conventional power plants was assumed. Other assumptions were: conventional fuel cost to increase gradually, fixed charges at slightly under 11 per cent, and a 50 per cent average load factor over a plant active life of 30 years followed by reserve standby use only. There is a 30 per cent spread in the per cent

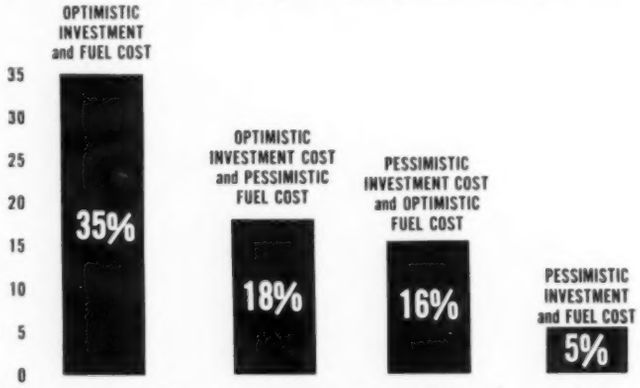


Figure 2 — Estimate of atomic generation in service as per cent of total generation in the year 1980.

of total generation. The closeness of the two middle bars indicates that reducing fuel and plant investment cost are equally important. The possibility of achieving the optimistic estimate emphasizes the importance of pushing development work now and the need for potential users of atomic power to become fully informed of its status and progress.

A rapid increase of the percentage of atomic plant capacity does not mean that conventional steam plants will rapidly become obsolete thereafter. The average of the Edison Electric Institute forecast of generating capability required in the country was given earlier for 1970 as 270,000,000 kw and for 1980 as 455,000,000 kw. Even for an optimistic assumption of atomic power plant growth, there is an increase in this ten-year period of some 120,000,000 kw of conventional steam capability, and it is likely to be more than this, requiring a high rate of manufacture of conventional steam generating equipment. These estimates would not indicate that conventional steam plants will shortly become obsolete or that efforts to improve turbine generators and other components should be curtailed because of the advent of competitive atomic plants.

A.E.C. POWER REACTOR DEVELOPMENT PROGRAM

Early in the year, the A.E.C. announced a reactor development program covering about five years and designed to develop new technology which would decrease the cost of nuclear power and encourage industry

to invest its own funds in research, development and construction of pilot and full scale reactor plants. Table VI shows the five projects in the program, their estimated cost, completion dates, experimental scale, and degree of development.

The large total project cost is indicative of the importance the government attaches to progressing rapidly toward economic power. If any one of the reactor projects demonstrates that a similar full scale plant would be economic, the money put into the program will have been paid a large return. If this does not happen, still a great deal will have been learned and we will be much farther along the road to economic power from the atom.

full-scale electric power generating reactor plant. Plutonium will be used as a fuel although some uranium 235 may be used at the start.

Three of these reactor systems will study breeding cycles. Breeding, making more new fuel from fertile material than is consumed in the process, is necessary if all the reserves of uranium and thorium are to be consumed. Breeding has great lone-range importance. If breeder reactors can manufacture excess fuel, it can be consumed in long burn-up converter reactors. This combination could make the power industry independent of the government's gaseous diffusion plants.

In addition to breeding possibilities, the homogeneous reactor using a fluid fuel has great potentiality as a low

TABLE VI

Project (research, development and construction)	Designation	Estimated cost (millions)	Estimated completion	Experimental scale	Degree of development	Electrical power 1000 kw
1. Pressurized water reactor	PWR	$ 85	1957	Full	Short term	60+
2. Boiling water reactor	EBWR	$ 17	1956	Medium	Medium term	5
3. Sodium graphite reactor	SRE	$ 10	1955	Medium	Short term	None
4. Homogeneous reactor	HRE-2		1956	Medium	Medium term	Not specified
	HTR	$ 47	1958	Medium	Long term	16
5. Fast breeder reactor	EBR-2	$ 40	1958	Medium	Long term	15
Total		$199				

The pressurized water reactor is expected by the A.E.C. to provide design and technological experience obtainable only from a full-scale plant operation. It should provide cost information of value in preparing better estimates of future plants. It is not expected, however, to produce electricity at costs competitive with conventionally fueled plants.

The experimental boiling water reactor is expected to demonstrate the extent of contamination of the turbine, condenser, feedwater pumps and other equipment outside the reactor by deposited radioactivity and the effect on maintenance procedures of deposited radioactivity. It will also demonstrate the high degree of self-regulation which this reactor appears to be capable of providing.

The sodium-graphite reactor test will evaluate fuel element performance, fuel element and structure temperature limits, and corrosion and radioactive transfer. It is believed that this reactor could be operated as a breeder on the thorium-uranium 233 cycle.

The homogeneous reactor, HRE 2, is to be built and operated to show the operability and reliability of this plant for long time operation at rated load conditions. As part of the cycle, chemical processing for purification of the fuel solution, corrosion of materials and chemical stability of the fuel solution will be studied. The HTR reactor, now in the planning stage, will be a two region reactor making uranium 233 from thorium. Associated with it will be two chemical plants; one, to remove fission products from the fuel and the other to extract uranium 233 from the thorium. Electric power will be generated from the heat produced in the reactor.

The fast breeder reactor is a scale-up of the original experimental breeder reactor which was the first to produce electricity and to demonstrate that breeding could be accomplished on a one-for-one basis; that is, that as much new fuel could be made as was consumed in the process. The components of the scaled-up breeder will as far as possible be like those contemplated for a

investment and fuel cost plant owing to its simplicity unless the difficulties of handling the enormously radioactive and corrosive fluid fuel place too great limitations upon its design.

The conception and initiation of this plan by the A.E.C. for reactor systems development and test is a major step in our progress toward economic electric power from atomic energy.

CONTRIBUTION POTENTIAL OF MILITARY PROGRAM

Also, contributing to the progress of atomic power is the A.E.C. work in the military weapon and propulsion machinery fields. Many of the problems attacked and solved have counterparts to which the solutions are applicable in the atomic electric power generation field. Some conception of the magnitude of the effort that the A.E.C. is expending to develop atomic energy may be gained from its commitments of money and manpower. The present A.E.C. investment in plant is $5,700,000,000. When the present planned expansion is completed, it will have spent approximately $8,000,000,000. These facilities include, besides those for production, the most modern research and development laboratories.

In the A.E.C.'s next-to last semi-annual report, it is stated that construction costs are at a rate of $120,000,000 a month. There are over 72,000 operating contractor employees, 64,000 design and construction employees and 6000 government employees engaged in the program. The breadth and magnitude of the technical program is indicated by the array of scientific and engineering talent employed in this program, shown in Table VII. This is truly a massive concentration of facilities and technical ability.

It is interesting to note that most of the people engaged in this program are young as is the industry itself. Most have come into the business since 1946. The majority have had one to eight years' experience, some 12 years and a few more than 12 years. This youthful

complexion of the business and its people has resulted in a vigorous attack in the many complex fields which must be comprehended. The important point is that we are building a large core of competent people and a vast fund of knowledge which are beginning to be applied to a significant extent to the production of atomic power.

TABLE VII

Scientific and Engineering Personnel, A.E.C.

Biological and medical scientists	1,617
Chemists	2,411
Physicists	1,708
Other physical scientists	738
Engineers — chemical	1,634
— electrical	1,346
— mechanical	1,843
— metallurgical	408
— other	1,907
Total	13,612

GROWTH OF STUDY TEAMS

The growth of study groups or teams is an indication of the spread of knowledge in industry of the facts of atomic power and its potentialities for industrial use. It is also a measure of the broadening of interest on the part of manufacturers, construction firms and users. These study groups have contracts with the A.E.C. which make available to them information applicable to their studies. In return, the A.E.C. has the benefits of the reports made to it by the study groups. Originally, there were four study groups. In the last few months of 1953, five new study groups were formed, including some of the original study group members. Three of these original groups continued making a total of eight. This last year has seen expansion of membership of one group and the formation of 10 more study groups. These groups now embrace a large cross section of industry. They include machinery manufacturers, construction contractors, engineering firms, chemical and metallurgical companies and electric power companies and other power users.

ARMY POWER REACTORS PROGRAM

One more indication of progress should be mentioned. The Army desires "package" atomic power plants to provide heat and electricity for remote bases. When the A.E.C., in cooperation with the Army, explored the possibility of obtaining bids at a fixed price to their specifications, they found 33 companies and associations of companies that were both qualified and interested to design, construct and test such a nuclear power plant. Eighteen of these submitted bids. This is a remarkably broad base of industrial manufacturing in such a new field.

THE OPERATING HAZARD, INSURANCE AND OTHER PROBLEMS

Progress in industrial atomic power development has now brought us face-to-face with some old problems which were recognized but in the background, and some new ones. Typical of the old problems which have now come to the fore is the hazard of operating an atomic reactor. While a reactor cannot explode like an atomic bomb, it is conceivable that it could get out of control through a combination of circumstances. The early solution was to locate the reactor in remote areas with control of access extended to surrounding areas so that protection of the people and property was by distance. For power plants which must be located near populous areas, a pressure-tight enclosure has been proposed. This would contain the reactor and other critical parts of the plant that might release radioactive or toxic materials.

Reactor plants are designed to be as inherently safe as possible and to incorporate many safety features in the control of the reactor and its associated systems. No reactor would be approved for construction until it had been carefully scrutinized from the safety standpoint.

Despite the excellent record of reactor operation to date and the use of every scientific safeguard, the remote possibility of a release of radioactive and toxic materials exists. It is possible for the operator or the supplier or both to incur liability that would exceed their entire assets. Insuring agencies are reluctant to provide coverage for such a hazard, as they do not have the knowledge, experience or reserves to supply atomic hazard insurance. A solution must and no doubt will be found for this problem.

Typical of the new problems for industry are those of obtaining sufficient information to see opportunities in the atomic power business and having found an opportunity to solve the financial, statutory, regulatory and administrative problems. So far in the study of atomic power for industry, the technical and engineering problems have tended to overshadow the business problems. With the broadened opportunity for private enterprise in atomic power, the thorough study of the business aspects is essential. Participation in study teams seem, so far, to have been the best way for industrial people or groups to get started in the atomic power generation field.

SUMMARY

In conclusion, atomic energy is making rapid strides toward an economically competitive position in the electrical generation business.

The new atomic energy act, increases the opportunity for industrial participation in the development of atomic energy processes for peacetime uses. The act changes a government monopoly in atomic energy, to control by regulation. Many features of this control and the potential liabilities of reactor operation will make this field a relatively expensive one in which to operate. We feel sure private industry will find a way to go ahead working with the government. The potential business is large and attractive.

The A.E.C.'s development programs for power reactor systems should lead to important new knowledge in a few years. The A.E.C.'s military program has contributed and will continue to contribute in a major way to the progress of atomic power. It is to be expected that industry will make substantial commitments in the near future and that industry's contribution to development work and plant construction will be accelerated.

We can look forward with confidence to an atomic generation industry taking its share of the energy requirements of our expanding economy.

COMMUNICATIONS in the steel industry

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Homestead District Works
United States Steel Corp.
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. . . . without modern communications, present mill operational procedures would be impossible . . . . loud speakers, telephone, carrier systems and radio all have their place . . . . equipment now in use is also rugged enough to withstand steel plant requirements . . . .

▲ FOR the purpose of this paper, communication in the steel industry is divided into two broad categories. The first involves the telephone, the teletype, remote writing, and inter-office communication systems . . . in general, those systems which primarily serve managerial and accounting functions. The second involves loud speaker systems, carrier phone systems, and mobile radio . . . in general, those systems which serve individual production problems at the workman level while the product is in process.

The first group will not be discussed except to note in passing that the status of these facilities are in no way impaired by the intrusion of the second. Rather, the two should combine to form a more integrated, useful tool for all concerned in the production of steel.

The second group is of relatively recent origin and has achieved, in its time, the status of indispensibility; in many instances without having originally been so designed. Seldom is it fully realized how often useful intelligence would be exchanged if the means of making the exchange were available. As a consequence of this basic underestimate, working procedures are evolved which include instantaneous voice communication as a necessary part rather than an accessory.

*At time of presentation of paper, now with Morgan Engineering Co., Pittsburgh, Pa.

THE LOUD SPEAKER SYSTEM

As here defined, the loud speaker system refers to those systems which are predominately made up of separate microphones, amplifiers, and speakers and does not include the inter-office devices with their self-contained amplification, talk-back speakers, and selective talking. The latter device is generally a shelf item with much shorter expected life than the former. At the writer's plant there are nineteen separate loud speaker systems consisting of over 170 microphone stations. Nine of the systems with a total of 42 microphones were installed between 1939 and 1948; the other ten systems with over 148 stations have been installed since 1948. Three of the last ten installations are two-channel systems.

The first speakers were installed in rolling mills and were specifically intended to solve an old, universally recognized, rolling mill problem which results from the necessity to make frequent changes in rolling orders. Proper steel not hot, leaning ingots in the soaking pit, crossed slabs in continuous furnaces, recharges, rerolls, changes in order, errors, etc., have always harassed the rolling mill operator and will continue to do so in the future. All these occurrences represent time lost until all concerned are notified. The loud speaker system represents the perfect solution to this very essential

communications problem. In retrospect, it is interesting to observe that this particular function of the system, this intimate association with the progress of the product through the rolling process, continued as its primary employment until around 1948 when broad coverage systems were installed in the blast furnace and open hearth. After that time, the full potentiality of the loud speaker as a paging and emergency device commenced to be exploited.

In 1948, a two-channel, 31-station system was installed to cover the entire blast furnace plant. No aspect of the operation was overlooked in the assignment of stations. Administration, power and fuel, all furnaces, chemical laboratory, maintenance, shipping, and plant protection were all included to constitute an installation which exceeded expectations at the outset.

The system serves a three-fold purpose: (1) operating routine, (2) paging, and (3) emergency. The operating people contend that any one of the three uses adequately justifies the installation.

1. In the normal operating routine, voice communication is much more satisfactory than signal lights and horns because the message can be given exactly without complicated coding. Telephone calls are still necessary for some types of messages, but those generally heard over loud speaker systems are complete before a telephone call could be connected. Typical of routine calls are those which follow:
   a. Humidity is announced every three hours.
   b. Laboratory announces analysis after every cast.
   c. Each cast is announced, alerting the railroad and the pig machine, and all others concerned.

Figure 1 — Unretouched photographs of loud speaker microphone stations show severity of steel mill service. Station on right shows trend to heavy duty design.

Figure 2 — Centrally located amplifier stations are ideal for observation, test and maintenance.

   d. Pig machine announces departure and make-up of empty ladles going to the furnaces. This allows keeper to get proper spouts ready; it also alerts the foreman so that he can be ready to spot the ladles.
   e. System gas pressure is much easier to maintain when all concerned with the system know what everyone else is doing. This function is very important to the operation of the blast furnace plant.

2. The paging value of a loud speaker system is much greater than is realized at first glance. Innumerable, extra, supervisory hours can be spent where they yield the greatest return . . . with the men they supervise.
   a. No ties are lost with their office or with higher supervision as long as they are in hearing range of a loud speaker.
   b. Meetings can be called on short notice to meet problems as they arise.
   c. When calls come in from the outside, an impression of efficiency is given when the party they are calling can be reached in a reasonable length of time.

3. When an emergency arises at a blast furnace, seconds count:

Figure 3 — This outdoor tap on a loud speaker system cable will last indefinitely.

a. In case of a serious accident, the gas rescue squad is alerted immediately. In addition, everyone else who can render any assistance knows where to go and what to do.
b. Failure of power, water, or blast air can cause serious damage if corrective measures are not taken immediately. The loud speaker gets through to all control points simultaneously.
c. In case of an iron spill, the cars must be moved before the wheels freeze to the tracks. Failure to do so can shut a furnace down for days.

All these things and many more have undoubtedly made this communication system of great financial worth to the blast furnace operations, but the values are so elusive that it appears impossible to even approximate a figure. However, if the unanimity with which it is acclaimed by the operating people is any indication, no blast furnace operation should be without one.

In 1949 a two-channel system was installed by the open hearth department. With respect to coverage, the system was similar to the blast furnace installation; in that all facets of the open hearth operation were served by microphones and speakers. With respect to success, it was also similar to the blast furnace installation in that all three uses, routines, paging and emergency, soon were commonplace.

Typical of the routine messages observed were as follows:

1. Ten minute notice to stocker boss—ready to charge.
2. Calls to high lift tractor to bank doors.
3. Calls pit boss for slag pot.
4. Numerous calls to the laboratory and the carbon analyzer during the course of the heat.
5. Summons the thermocouple man—two readings minimum.
6. Orders extra hot metal when needed.
7. Calls for ladle if heat is ahead of schedule or if one has not been placed.
8. Calls for dolomite machine after heat is tapped.

The paging function saves countless steps and innumerable telephone calls in an open hearth. Paging calls are so frequently heard over the systems that one wonders how this type of communication was formerly accomplished. Actually, only a small percentage of these calls could possibly have been realized prior to the loud speaker. Many questions were left unanswered and much valuable intelligence was not exchanged.

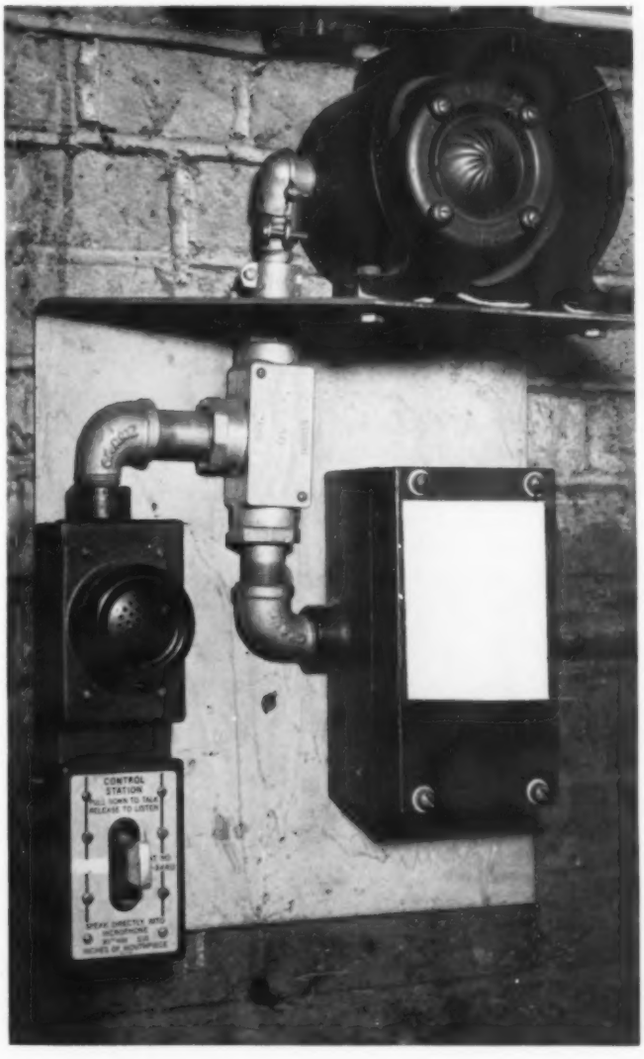
In emergency, the loud speaker fills a long felt need. Motor inspectors and millwrights are called for many unforeseen occurrences on every operating turn. Fuel engineers can be called instantly for troubles on the furnace controls. The labor foreman is frequently called to help with furnace troubles requiring additional manpower.

These, to mention only a few, are the reasons why the operators claim that they could not do without the loud speaker system and hope to maintain full production. But, again, when any attempt is made to evaluate the financial gain made by the installation, the intangibles become so numerous that any figure chosen is meaningless.

The loud speaker system has proved its worth in the rolling mill, the blast furnace, and the open hearth. In using the systems over the years in widely varied environments, certain experience has been gained pertinent to: (1) the selection, (2) the installation, and (3) the maintenance of loud speaker systems. Following is a brief discussion of these factors:

1. The selection of loud speaker systems resolves itself into two broad considerations, the physical design and the electro-acoustic design. The physical design deals with the manner in which the

Figure 4 — This ground station of an overhead crane carrier communication system is ruggedly built for steel mill service.



various components will withstand industrial use and how often they will require maintenance. Thus, the following construction features are considered necessary.

a. The microphone station.
   1. The microphone and microphone switch housing must be of heavy plate or cast. The cover assemblies should be gasketed.
   2. Whenever possible the microphone should be stationary, to afford maximum protection to the microphone element. When extension microphones are necessary they should retain "industrial" appearance.
   3. Microphones or microphone elements should be easy to replace.
   4. Microphone-speaker switches should be ruggedly built. Contact resistance is of much greater importance on a microphone circuit than it is on the usual industrial pilot circuit; therefore, greater attention must be given to the manner in which the contact is made. A wiping action appears to be almost essential for long trouble-free service.

b. The amplifiers.
   1. The amplifiers should be installed in standard relay racks and the whole assembly enclosed consistent with dirt conditions at the amplifier location.
   2. The individual amplifiers should be connected in such a manner that they can be easily removed and replaced.
   3. The amplifiers should be amply powered to allow for expansion. Additional stations are inevitably added.
   4. Adequate facilities for observation and test should be provided at the amplifier station.

c. The speakers.
   1. The speaker should be chosen to fit the application, especially as to directivity. Directional speakers, where applicable, produce more sound at the listening point with less power. They also reduce reflection problems around the hard, non-absorbing surfaces usually found in a steel mill.

Figure 5 — Mobile radio enables the yardmaster to dispatch locomotives with an efficiency undreamed of before its installation.

   2. The speaker should be ruggedly built, and sealed against the entrance of dirt and magnetic particles as completely as acoustics will permit.

The above physical characteristics are relatively easy to obtain on today's market due to the increasing efforts of the suppliers to make their equipment fit the needs of industry. The wide variety available will fill most needs. The second consideration, the electro-acoustic design is an infinitely more difficult problem to resolve into clean cut specifications.

The prime objective of the design of any voice communication system is to produce a system which will reproduce speech intelligibly. The listener must clearly be able to understand the talker if the system is to serve its intended purpose. It is desirable that the sound be as natural and pleasant as possible, but fidelity is a secondary consideration. It is not possible in a paper of this scope to develop data necessary to insure the best possible system, but an awareness of contributing difficulties, and a realization that an intelligible sound system can be designed for practically all steel mill environments is a practical armament for the prospective user of a sound system.

Primarily, the character and intensity of the ambient noise engulfing the listener determines the intelligibility of any system being operated within its power rating. The reason for this is that noise has a masking effect on the voice in a manner which is determined by the frequency components of the noise and of the voice as it is put out by the loud speaker. If the speaker is putting out predominantly the same frequencies as the surrounding noise it amounts to direct competition similar to the situation which exists when two men, side by side, try to yell different messages to a confused listener.

The solution to the noise problems lies in the frequency response characteristics of the air-to-air system including the microphone, the amplifier, and the speakers. By proper selection of these components it is possible to "cut through" most steel mill noises. The reason this is possible is that most of the power in noise appears in the frequencies below 500 cycles, also most of speech power appears in these same frequencies, but fortunately, the sounds in these lower frequencies are vowel sounds which, when eliminated, detract very little from the intelligibility. Thus, by cutting off these lower frequencies a more crisp, understandable speech emits from the speakers.

Often, this is not sufficient because the noise may spread into higher frequencies. When this is the case, it is necessary to incorporate into the system a characteristic of rising response with rising frequency. While this method produces a shrill, high pitched quality to the voice, it is the only solution available to some extreme noise problems.

2. When preparing installation specifications for loud speaker systems, the guiding principle determining the materials and methods to be used should be "permanence." Todays systems can be expected to last indefinitely and the following material and installation considerations have become standard.
   a. The output and input lines are all shielded. A

single multi-pair cable with an all-purpose plastic jacket is used.

b. The main cable run is generally supported on steel messenger but the cable is self-supporting on short spans.

c. Taps from the main run are made by the employment of ruggedly constructed weatherproof terminal boxes in which are mounted screw-type terminal boards similar to those employed in low voltage control wiring.

d. Drops to microphone stations and speakers are made in rigid conduit.

3. A properly selected and installed loud speaker system requires very little mantenance in the usual sense of the word. Most of the costs associated with their upkeep will be in the nature of repair rather than maintenance. Since the same personnel maintains both the loud speaker systems and the crane-to-ground carrier systems, this subject will be dealt with separately following the discussions of the carrier systems and the mobile radio.

CARRIER PHONE SYSTEMS

As herein discussed, the subject of carrier phone systems is limited to its application as a means of voice communication between moving machinery which collects its electrical power through trolley wires, collector rails, or portable electric cable, or between such machinery and ground stations as can be connected to the same source of power.

Our first such unit was installed in 1947 on the pit cranes at a slabbing mill. Since then six additional systems have been installed at various locations throughout the plant:

1. Slab mill soaking pit cranes to recorders ground station.
2. Structural beam mill soaking pit cranes to recorder and ingot transfer buggy operator.
3. Structural shape mill soaking pit cranes to recorder and ingot transfer buggy operator.
4. Slab mill piler operator to slab yard cranes.
5. Open hearth metal mixer to hot metal cranes.
6. Open hearth metal mixer to metal mixer crane to ground station for railroad.
7. River dock gantry crane to ground to barge.

Under active consideration also is a system to cover the ore bridges at the blast furnace. This is a common application in many steel plants throughout the country and from all reports is very useful to the operator.

The soaking pit is a very fertile field for communications. There are so many unpredictable occurrences associated with the charging and drawing of ingots in a high tonnage mill that, it is hard to imagine how they operated prior to installation of these systems. Whenever an ingot leans the wrong way in a pit, it is often necessary to change the order of drawing from that pit to minimize the difficulties involved in extracting the leaning ingot. Change in the rolling order is very simple, if the pit craneman has means of contacting the pit recorder and acquainting him with the situation. Without the means of wire communications, this simple requirement becomes a yelling, pointing, running back-and-forth operation which wears tempers thin and invariably slows down the production process. Of all the carrier systems installed, it is our belief that the soaking pit installations represent the greatest financial return.

The open hearth installations are in two different type shops from the hot metal standpoint. In one shop, the metal is delivered from the mixer directly to the furnaces by the hot metal cranes. At this shop the mixer is also filled by the same cranes. In the other shop the hot metal is delivered to the furnaces on a transfer car then delivered to the furnace by the hot metal cranes. In this shop the mixer is filled by a mixer crane.

In the first shop, the older by many years, there is considerable congestion in the region of the mixer. The mixer man is constantly in need of means to direct the movements of the hot metal cranes. The carrier phone is the perfect answer to this need. This system also has a ground station in the maintenance office. Much time can be saved by the motor inspector if he can know, by the craneman's description, the nature of the repairs needed before he boards the crane. It is also a valuable means of scheduling regular preventive maintenance and crane inspections at the best possible time.

At the second shop there are three important people involved in the operation of keeping the mixer filled: the mixer man, the crane operator, and the conductor of the train bringing in the ladles from the blast furnace. The three are just enough distance separated to make voice communications possible to only the most robust vocal equipment and the sharpest ears. This yelling, combined with waving and pointing, seldom constitutes a satisfactory exchange of information. The installation of carrier phones for the use of these three has contributed greatly to the smooth operation of the metal mixer. In addition to the time saved in this operation, there is the safety factor involved in the premature movement of ladles by the engine before the ladle arms of the hot metal crane clear the ladles.

Considerable shipping and receiving by river barge is done at the author's plant. The loading and unloading is done with a gantry crane. Frequent communication is required between the craneman, the men at the railroad yard level, and the men in the barges. During daylight hours when the weather is such that the cab windows can be open, a passable communication is achieved by the usual shouting, waving and pointing. But in the dark hours in all weather and at all times during cold or inclement weather, communication by these means is highly unsatisfactory and requires an almost intuitive cooperation among the principals to operate safely and efficiently. Installation of carrier communication at this location, while not complete at this writing, is expected to improve dock operations from all viewpoints.

In all cases, our carrier system installations have accomplished their intended purpose. At the present time it is very difficult for a prospective user of this equipment to make a poor choice, because, to our knowledge, there are only two sources of supply for this type of equipment. Both manufacturers entered the field well fortified with knowledge of steel mill design requirements and were, at no time, furnishing "warmed

over" commercial equipment. As a result little need be stated regarding selection of systems except to note that the same principles are involved as in the loud speaker systems with the exception that the electro-acoustic design is somewhat simplified due to the fact that the listener is generally very close to the speaker and is usually shielded from excessive surrounding mill noises. However, this simplification disappears when the speakers are used to cover large areas, where ambient noise is high. In this case, the intelligibility problem becomes the same as discussed under loud speaker systems.

MOBILE RADIO SYSTEMS

In 1946, we made our first mobile radio installation. It consists of one base station and eight mobile units installed on the diesel locomotives serving the portion of the plant which was constructed between 1942 and 1945. As this new portion of the plant grew in productive capacity, the problem of dispatching the engines grew with it, to the extent that engine delay became a serious impediment to the further growth of that productive capacity. Engines were almost always available, but having them in the right place at the right time was the task of the yardmaster who travelled on foot from one engine to another, picking up telephone messages at his office between trips. This form of communication was very slow and on busy turns often taxed the physical endurance of the yardmaster.

After the radio was installed, the change which took place was difficult to believe. The yardmaster's job was changed from a tiring physical function to one which is practically sedentary. The locomotives can be located and dispatched instantaneously, saving many hours of walking, telephoning, and message relaying; at the same time the intended functions are performed with an efficiency wholly impossible without the radio.

The original choice of equipment for this installation was made completely without experience. It was thought that the entire field of mobile radio manufacture could be considered without regard to specialized application. The equipment chosen had been highly successful in the automotive field, but no amount of alteration, remounting, or redesigning could make it stand up on the locomotives. Finally, after several months of unsuccessful operations, it was returned to the original manufacturer and replaced with equipment specifically designed for railroad service. The new equipment proved to be very successful and has operated continuously since installation with very little trouble.

Much more extensive use of radio is contemplated for the near future. Some of the applications under consideration which have already proved valuable in other steel plants are as follows:

1. Plant protection vehicles, ambulances, and plant gates.
2. Plant trucks and service cars.
3. Locomotive cranes.
4. Maintenance crews using portable radios.

The possibilities for the future appear to be limited only by the imagination. Printed circuits, sub-miniature tubes, transistors, and new battery developments are opening vast fields for portable application. These miniature parts can and probably will bring many more workman and front line supervisors into instantaneous communication with central coordination points and should result in reduction of manpower to the minimum required for maximum efficiency.

As stated earlier, the maintenance of the various systems herein discussed is generally handled by one centralized group. At first glance it would appear that this group would necessarily be composed of highly specialized technicians. While some specialized training is necessary, it appears that journeyman wireman can cope with all but the mobile radio and the more difficult amplifier problems. Due to the fact that the Federal Communications Commission requires frequency certification by properly licensed operators, our mobile radio unit is maintained by an outside contractor. The difficult amplifier problems are overcome by providing each system with spare amplifiers which can be connected with a minimum outage time. The faulted amplifier can then be brought into the shop for examination and repair, or shipment to outside shops for repair. This makes a very flexible arrangement insofar as force requirements are concerned. The trend in equipment designed is toward long trouble-free service with simplified plug-in parts for the more sensitive circuit elements. If the trend continues it is very possible that the regular mill mantenance personnel will be able to assume the major portion of the maintenance involved as part of their regular duties. Should this come to pass, reduction of maintenance hours by a central group is much simplified when the personnel are tradesmen who can readily be shifted to other work.

In conclusion it is safe to say that instantaneous voice communication will improve any operation where production is dependent upon the action of individuals. The extent of the improvement is almost universally under-estimated. The steel industry has accepted these new production aids and has contributed much to the art of voice reproduction by providing a market for high-quality, rugged equipment. The market should expand as the benefits are fully recognized and new ideas to reduce upkeep are marketed.

DISCUSSION

PRESENTED BY

JAMES D. O'ROARK, Assistant Manager Service and Maintenance, Weirton Steel Co., Weirton, W. Va.

WILLIAM C. REEDER, Foreman, General Services, Electrical, National Tube Div., United States Steel Corp., Lorain, Ohio

ROBERT V. KINNEY, District Manager, Commercial Equipment Dept., General Electric Co., Pittsburgh, Pa.

James D.O'Roark: I certainly concur with the emphasis which the author puts on the benefits to be derived from these particular types of industrial communications.

Mr. Hughes has discussed the subject as applied to the steel industry. The application and benefits would be practically the same for any other industrial esablishment of major size involving numerous buildings, production flow, interconnected yard area, transport, material handling, etc.

Unfortunately, industry as a whole has been slower than many other enterprises to recognize and adopt such types of communication as discussed by Mr. Hughes, particularly mobile radio. If you check the FCC frequency assignments, you will find such groups as aeronautical, public safety, maritime, land transportation, citizens radio, forestry service, power radio service and many others having frequency band assignments much more generous than those allotted to industrial radio service—an indication that these enterprises recognized the value of radio communication and got in on the ground floor, so to speak. As a result, the limited frequencies available to industrial radio service may pose a handicap to those eventually desiring to purchase and use radio in their industrial operations. This is particularly serious in large industrial areas such as Detroit, Chicago, Los Angeles, etc., where interference and overlapping could be a serious deterrent to satisfactory radio usage. In such large areas, it would be very necessary to check existing frequency assignments and satisfactory band separation as a prerequisite by anyone contemplating the use of radio.

Assuming that a particular industry has decided to use radio or other types of equipment as covered by Mr. Hughes, it is no longer necessary to take a chance on the make, proper design, or performance of any such equipment, since several proven types and makes are available, and their performance can be readily verified from the many users. Now as to the wired systems, Mr. Hughes has very factually and accurately covered the justification, benefits and equipment details of such applications such as in an open hearth, blast furnace, finishing operations, etc.

At Weirton Steel, we have similar installations in those departments, but wish to make particular note of a two-channel communication system between our high pressure boiler house, low pressure boiler house, and power generating station, and between power generating station and main river pump house. These are highly critical points in our plant operation, and we feel that this inter-communication system furnishes the ultimate in the necessary close and efficient coordination of these departments. I might also mention the use of marine radio between harbor tugboat and wharf, also a low power unit between car dumper and locomotive—necessitated by interference in line of sight.

With the advent of enclosed, air conditioning crane cabs in many phases of steelmaking, the old hand signals or shouting can no longer be used to direct the craneman's movements. Here the carrier system through the 250-volt, d-c crane rail provides positive two-way communication. We might add that when this type of equipment was first installed about four years ago, difficulty was encountered due to too light resistors, inadequate fusing and generally construction not able to withstand the ambient heat of such operations. These difficulties have been corrected and only a very nominal mantenance is now required. The use of so-called differential microphone has largely solved the problem of pick-up of surrounding noises.

In regard to mobile radio equipment on diesel yard locomotives, the major maintenance item was servicing the rotating power unit which fed from the cranking battery. This was corrected by replacing the rotating unit with two vibrator units, one in service, which automatically cuts over to the spare if the first one fails. The vibrator replacement cost was considerably less than the maintenance cost on the rotating power unit. Mobile radio equipment, as well as the other communication systems, have unit assemblies, making for quick field replacement and easy shop repair. Weirton Steel Co. personnel installs and services all such communication equipment, numbering approximately 75 systems of different kinds.

Anyone contemplating the purchase and use of any of the communication systems herein dealt with, should not buy on price alone which might result in poor performance, high maintenance cost and an unfair conclusion as to the worth of such equipment. Instead, it should be of high quality parts and workmanship, it should be carefully designed, taking into account the surrounding conditions and circumstances under which it must operate, it should be of unit construction for ease of maintenance, after all these specifications are adequately met, then consider price, not before.

In most any large industrial plant there are usually a number of radio "hams" who have accumulated knowledge and experience with electronic equipment, many of which have commercial licenses and we feel that it is advisable to put this lot of equipment under one or more men with this particular training and thereby provide capable and uniform service throughout the plant. The nature of the equipment, along with special test meters and devices required, I feel, legitimately takes the mantenance out of the hands of the usual motor inspector or similar mill service personnel. Too often good equipment which could be very beneficial to production is given a black eye and condemned through lack of proper maintenance personnel.

Again let me join Mr. Hughes in praising the worth and recommending greater use of good communications in not only the steel industry but in all industry.

William C. Reeder: Mr. Hughes has covered the field of communications in steel mills admirably, and I have been impressed with the similarity between his experience at Homestead Works and our experience at Lorain Works. In commenting on Mr. Hughes paper our remarks will of necessity be based on the practice with which we are most familiar, namely at the Lorain Works of National Tube Division.

The points brought out relative to blast furnace installations are of special interest inasmuch as these installations so closely parallel our own. In this connection, I would like to mention that our system includes an auxiliary power supply which will keep the intercom functioning in the event of a power failure. Each of the 35 stations is also equipped with an emergency button that enables any party to cut off all other parties using the system if it is necessary to get an emergency message through.

We do not contract our radio repair service; we utilize a spare unit which can be quickly exchanged with a unit that has failed. The faulty unit is then sent to our repair shop and put in good condition for use wherever the need develops. Frequency measurements and repairs are supervised by the foreman who holds the required radio telephone license.

We are not entirely satisfied with the intercom installations on our ore bridges. The bridge runway is 3,280 ft in length. We have installed chokes in the lighting and heater circuits to cut down losses, and we are moving the receiver and transmitter from the docks office to the center of the runway to improve the operation.

We are eliminating dynamic microphones utilizing the light foil diaphragm throughout the plant in favor of the standard telephone monophone that uses the receiver capsule. The capsule has performed well in all locations having an impedence that matches a 200-ohm mike line without requiring transformers. The capsule has good speech response and costs approximately one-seventh of the cost of a dynamic microphone. We are experiencing good results on other systems using carbon and crystal microphones, although replacement maintenance on the crystal is excessive in locations where heat and humidity are high.

We have experienced considerable trouble with mercury switches and the pushbutton switches without wiping action, and have commenced a program of replacement with lever switches tightly enclosed employing good wiping action.

We use a standard mobile two-way radio on our narrow gage diesel locomotive. Except for the rotary inverter (32-volt, d-c to 110-volt a-c) brush wear on the primary side, maintenance of these units is normal. This condition has been improved by the installation of a one ohm series resistor.

Our motorized truck doors are opened and closed by the two-way radio on the straddle carriers and fork trucks. This simple little receiver utilizes a sensitive relay and silicon diode rectifier. The system is far superior to the supersonic system we formerly used. Incidentally the radio equipped straddle carriers and fork trucks have proved invaluable in speeding up the transportation of pipe and tubular products.

Communication equipment at Lorain Works consists of the following:

Private Branch Exchange (864 Phones).
3 — Direct lines to Pittsburgh.
10 — Two-way trunks to Lorain.
4 — Toll trunks to Lorain.
No. 4 Bloom — 30 PAX phones.
No. 4 Seamless — 25 PAX phones.
20 — Private magneto phones — various locations.

High Level Audio Communication
35 — Station two channel system at blast furnaces.
6 — Stations at the open hearth.
10 — Stations at the coke plant.
30 — Stations with three overlapping amplifier systems in the No. 4 bloom mill.
10 — Stations in No. 4 seamless mill.
8 — Stations in the bessemer.
15 — Various office intercoms.

Carrier Current FM Systems
3 — Ore bridges.
1 — Docks office.
No. 4 Bloom mill — 10 units on pit and cover cranes.

Two-Way Radios
10 — Straddle trucks.
3 — Fork trucks.
1 — Base station.
1 — Patrol car.
2 — Tow trucks.
7 — Narrow gage locomotives.
4 — Handy talkies.

R. V. Kinney: I would like to say that too often the procurement and use of communication equipment to increase the efficiency of the operating departments of the steel mill has gone unnoticed. Mr. Hughes' paper clearly identifies the use of communications equipment and similar results can be found in a good many industries all over the United States.

Once the communication equipment has been installed there is always an incident where without communications equipment the delay and loss of production exceeded the original cost of the equipment many times, and this is rather hard to believe.

I was very happy to note the reference to mechanical stability to equipment used in locomotives. Here the shock exceeds many times those values associated with the so-called rubber-tire equipment.

Our company has long been cognizant of mechanical stability and its relation to electrical operation where the equipment is subjected to severe shock. The mechanical design is equally as important as the electrical design.

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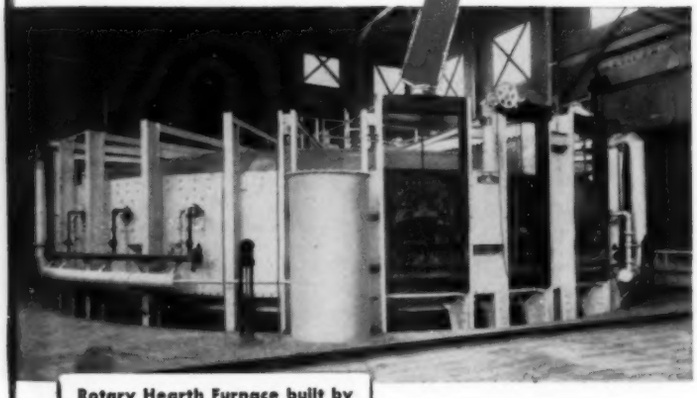

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MALLORY-SHARON TRIPLES TITANIUM MELTING CAPACITY

▲ COMPLETION of a new melting plant, which triples titanium melting capacity, is announced by Mallory-Sharon Titanium Corp. of Niles, Ohio. This is just one step in the continuing program of production expansion and product improvement for which Mallory-Sharon has been responsible since its beginning in 1951.

The new plant houses four double-melting furnaces, used for both first and second stage melting of titanium from sponge to ingot form. This increases Mallory-Sharon's melting capacity to 3,000,000 pounds a year. These units combine the best features of "Method S," consumable electrode-double melting, and new vacuum melting techniques.

In this process, titanium sponge is first compressed into long electrodes on large hydraulic presses. The electrode is then fed into a vacuum melting furnace, where it is arc melted, forming a solid ingot. This "first-stage" ingot is then used as an electrode in a second melting operation, yielding a final ingot weighing approximately one ton.

Ingots produced by this method, developed by Mallory-Sharon, are highly homogeneous and display the same characteristics throughout. Alloying elements can be closely controlled and properties held constant from melt to melt. In addition, the method increases the yield from sponge to ingot. The importance of this is evident in view of the fact that scrap loss in melting is about 40 per cent on bar stock; about 50 per cent on sheet. The process is also adaptable to the recycling of scrap titanium.

The entire furnace installation is made with a careful eye to personnel safety. Furnaces are arranged in explosion proof steel barriers with relief walls that vent to the outside of the building. Technicians who operate the process are stationed at remote control panels. These precautions are taken because of the high temperatures involved in melting.

In addition to the furnaces, the new plant houses press equipment, a blending room, area for titanium sponge storage, and there is room for additional melting capacity when it is required. Other features of the melting plane are:

Power—To operate the new furnaces, Mallory-Sharon installed a 2500 kva substation adjacent to the plant addition. Two banks of selenium rectifiers and one bank of germanium rectifiers convert a-c power to direct current for furnace use.

Press equipment—Presses are adjacent to the melt shop in the new building. The company has installed a 3000-ton press for compressing titanium sponge into electrodes. Another 1500-ton press will shortly be moved from the P. R. Mallory Co. in Indianapolis.

Blender—This is designed to produce uniformity in mixing different grades of titanium sponge.

Mallory-Sharon's Niles plant embraces all the facilities needed for converting titanium sponge into finished flat rolled products required by fabricators. Ingots produced by the melting plant are converted by the adjacent rolling mill and other Sharon steel facilities into sheet, strip, plate, bar, rounds, and other shapes. The Mallory-Sharon titanium laboratory is used for both exacting quality control in processing, and research and development of new alloys.

Mallory-Sharon's expansion demonstrates its faith in the future of the new metal. Company officials point

Figure 1 — Mallory-Sharon's four new furnaces are installed in groups of two each. At right are two furnaces, enclosed in steel barriers as a personnel safety precaution. Furnaces are reached through vertical-sliding doors. Power supply comes from bank of 1000-w power units seen on the platform above, with germanium rectifiers located below the platform.

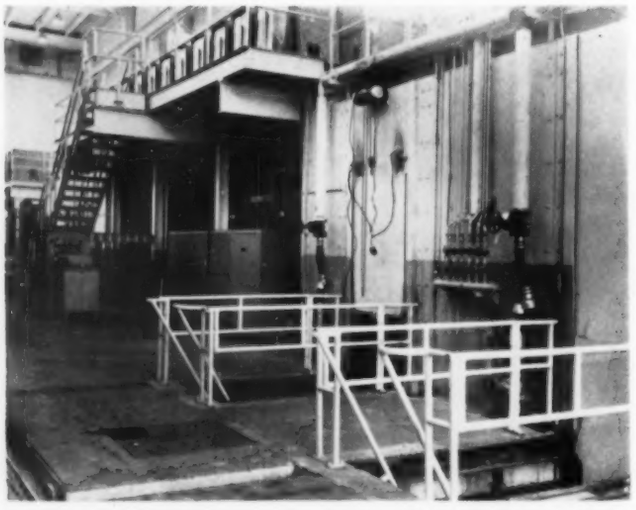

Figure 2 — One control panel designed specially by Mallory-Sharon engineers, serves all furnaces. The remote set-up contributes to personnel safety by removing operators from immediate area of furnace operation. The system was devised by Mallory-Sharon engineers with the cooperation of many safety experts from private industry, the AEC, the U. S. Bureau of Mines and other organizations.

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CAMPAIGN RECORD 60-TON TOP CHARGE ELECTRIC FURNACE

END OF CAMPAIGN	TOTAL HEATS	HOURS LOST ON REPAIRS	REFRACTORY	REASON FOR LOST TIME
5/10/52	86	12:10	No CORHART 104	Two large patches to walls and gunning time.
8/28/52	93	10:20	No CORHART 104	Two large patches to walls and gunning time.
10/9/52	118	6:50	Some CORHART 104	Brick or gunning repairs.
11/7/52	103	12:05	No CORHART 104	Two large patches.
1/4/53	90	4:10	No CORHART 104	One large patch and gunning time.
2/5/53	105	4:35	No CORHART 104	One large patch and gunning time.
3/13/53	126	4:25	CORHART 104 in *"Hot Spots"*	Patching top of wall and gunning wall.
4/16/53	136	11:40	CORHART 104 in *"Hot Spots"*	Brick repair to top of walls only.
5/26/53	127	8:55	CORHART 104 in *"Hot Spots"*	Brick repair to top of walls only.
7/1/53	129	5:05	CORHART 104 in *"Hot Spots"*	Brick repair to top of walls only.
8/5/53	117	15:25	No CORHART 104	Three large patches and wall gunning.
9/23/53	119	5:10	Some CORHART 104	Brick and wall gunning.
11/7/53	137	10:05	CORHART 104 in *"Hot Spots"*	Patching top of walls.
2/17/54	105	7:10	No CORHART 104	One large and one small patch.
4/11/54	151	10:20	CORHART 104 in *"Hot Spots"*	Patching top of walls.
5/31/54	146	12:35	CORHART 104 in *"Hot Spots"*	Three small patches to top of walls.
9/4/54	135	22:30	CORHART 104 in *"Hot Spots"*	Patching top of walls.
10/8/54	143	13:25	CORHART 104 in *"Hot Spots"*	Patching top of walls.
11/17/54	135	4:05	CORHART 104 in *"Hot Spots"*	Patching top of walls.

Average heats per campaign without CORHART 104.....100
Average heats per campaign with CORHART 104 in *"Hot Spots"*.....137

THE two and one-half year furnace log above shows that, when using Corhart 104 Electrocast Refractory, the operators of this 60-ton electric furnace averaged 37% more heats per campaign. Yet the Corhart 104 represented only about 10% of the total sidewall refractory requirements!

Corhart 104 is a revolutionary magnesite-chrome refractory which is electrically-melted at 4500°F, and then cast into its final shape. It is used in hot spots, to help "balance" sidewall wear in electric furnaces and open hearths.

Write for complete technical information. If you will describe your operations, we'll be glad to suggest applications and estimate costs. Corhart Refractories Co., *Incorporated,* 1620 West Lee Street, Louisville 10, Kentucky, U.S.A.

QUALITY ECONOMY ENDURANCE

CORHART 104 ELECTROCAST REFRACTORY

The words "CORHART" and "ELECTROCAST" are registered Trade Marks which indicate manufacture by Corhart Refractories Company, Incorporated.

For Reliable Rectifier Operation Get

Continuous Excitation

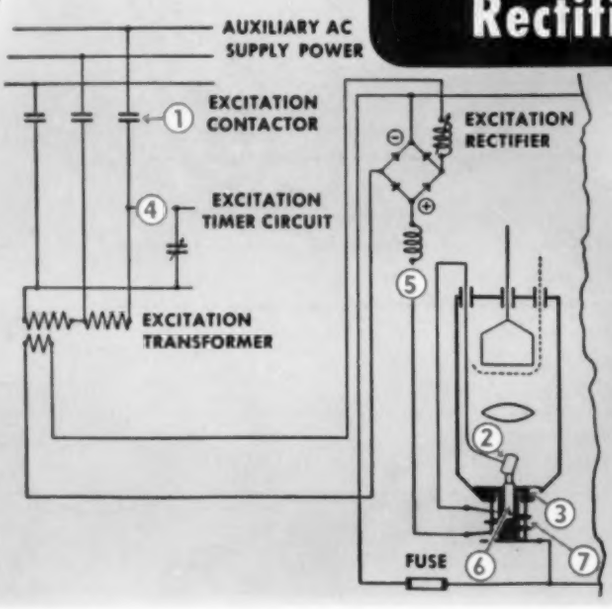
Allis-Chalmers excitron rectifiers eliminate the need for a pulse-type firing system timed for operation every cycle. Maintenance is easy because of the simplicity of design.

A small dc excitation arc is automatically ignited only once, when the unit is started, and then maintained on the mercury cathode of each rectifier tube. It offers advantages similar to a pilot light. Since it is far easier to maintain an arc than to start it, this feature makes the excitron far less likely to lose excitation during power supply disturbances than other types of rectifiers.

Get all the facts about excitron rectifiers before your next installation. Call the A-C office nearest you or write Allis-Chalmers, Milwaukee 1, Wisconsin.

ALLIS-CHALMERS

Mercury Arc Rectifiers



Supply of DC Provides Key to Continuous Excitation

Direct current supplied from excitation rectifiers is the key to continuous excitation. When the excitation system is energized by means of a contactor (1), positive dc potential appears on the excitation anode (2) of each tube, negative at the cathode (3). A timer (4), through contacts of the excitation failure relay (5), is energized at the same time.

As soon as voltage is applied, current flows from the anode to the cathode through the ignition plunger (6). This current energizes the ignition coil (7) and causes the plunger to be pulled below the mercury surface. As the plunger travels down, an arc is drawn which transfers from the graphite tip of the plunger to the mercury. This current flow keeps the coil energized, maintaining a continuous arc.

If excitation failure should occur while the rectifier is carrying load, the plunger is released, floating upward in the mercury until it makes contact with the anode, then repeating the process above until the arc is re-established.

Re-establishment of the arc as outlined takes less than a second — it does not interfere with normal operation.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

A-4592

Figure 3 — Located in the melt shop, this 3000-ton hydraulic press compresses sponge titanium into consumable electrodes prior to melting operations. Another press, a 1500-ton model, is used on the same operation.

out that the potential market for titanium in aircraft alone is many times greater than the industry's total production today. At the same time, current demand has been lagging, as aircraft manufacturers have been awaiting more production-in-being before committing new aircraft designs fully to titanium. Efficient new capacity, such as this, is expected to help win faster acceptance of titanium.

At present, prospects for expanded commercial application of the metal are bright. Although developed under military sponsorship, titanium now is available commercially. It has some marked advantages to attract designers who can be sure of its ready availability.

Titanium is impervious to marine atmospheres and salt water. It withstands many destructive chemical atmospheres such as nitric acids and strong alkalies. For these reasons, it offers broad application in chemical, food processing, refining, mining, and other processing industries.

Excellent erosion resistance to steam indicates further use for turbine blades and rotating members

Figure 4 — Ingots weighing approximately one ton come from furnaces after double melting. Hardness testing, shown here, is one step in quality control of the finished ingot.

and possibilities for condenser and heat exchanger tubes.

In ordnance production, high strength offered by the lightweight metal is being exploited in weapon components and airborne equipment. Of course, applications in military aircraft are better known and more extensive.

As one of the major forces in bringing the titanium industry to a point where it can anticipate substantially increased demand for its product, Mallory-Sharon has been responsible for several firsts. Among the more significant are the following:

The first production titanium alloy (MST-3A1-5Cr) with ultimate strengths of 165,000 psi, and up.

The first complete laboratory in the United States established solely for titanium research and development.

Originator of the double-melting process for production ("Method S"), resulting in highly homogeneous ingots, in which carbon can be held as low as the amount inherent in the sponge material.

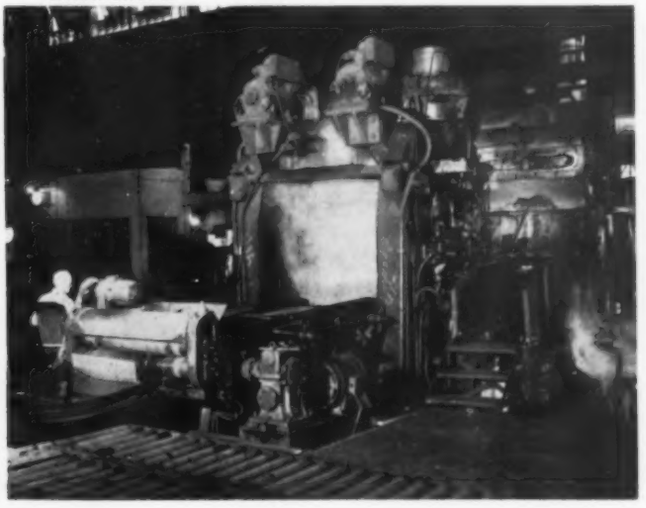
Patented rolling method, which reduces oxidation when titanium is heated for rolling.

First to commercially produce the 6A1-4V alloy, the first weldable and heat-treatable titanium alloy. (Developed by Armour Researh Foundation and Watertown Arsenal of the Army Ordnance Corps.)

First to commercially produce the 3 Mn Complex alloy, the first heat-treatable titanium alloy. (Developed by Battelle Memorial Institute).

Mallory-Sharon Titanium Corp. was incorporated in 1951 to develop the then relatively unexploited metal titanium. In the few years since this beginning, both the company and its product have advanced markedly and Mallory-Sharon now produces a complete range of titanium and titanium alloy mill products. Mallory-Sharon was founded and is jointly owned by P. R. Mallory and Co., Inc., Indianapolis, and Sharon Steel Corp., Sharon, Pa.

Figure 5 — (below) Mallory-Sharon's completely integrated operation, from sponge through finished titanium sheets and shapes, includes this conveyor and furnace set-up to heat plates prior to rolling. Figure 6 — (right) Titanium rolling operations are performed on facilities of Sharon Steel Corp.'s Niles rolling mill, which adjoins the Mallory-Sharon titanium production facilities. Operation shown is breakdown rolling on a three-high mill from ½-in. sheet bar to ⅛-in. thick sheet.



Alcoa Starts Operation of two new Aluminum Welded Tube Mills

▲ PRODUCTION has been initiated on two new aluminum welded tube mills at the Aluminum Co. of America works, Alcoa, Tenn. The new mills provide Alcoa with the capacity to produce welded aluminum tube and pipe from ½ to 8 in. diameter. One of the mills will produce tube from ½ in. to 4 in. (outside diameter); and the other can make tube from 2 in. to 8 in.

Aluminum welded tube of this type has not been generally available until the past year, although Alcoa has produced welded heat exchanger tubes on a pilot mill for several years.

The first products available from the new mills include 1 in. Alcoa Type 1 welded furniture tube and three sizes (3 in., 4 in., and 6 in.) of Alcoa Alclad welded irrigation pipe (also sold as construction pipe).

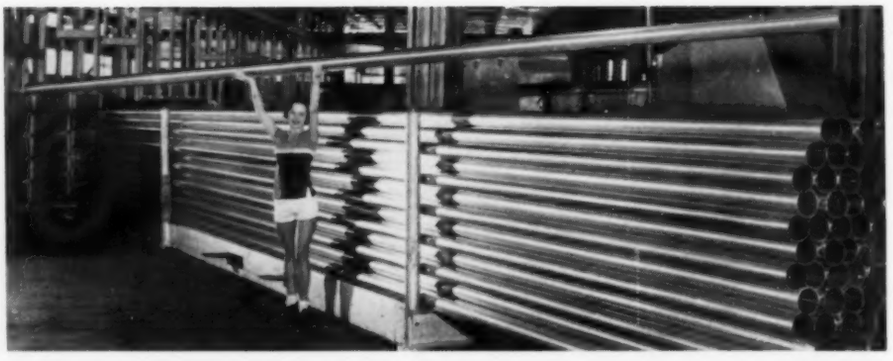
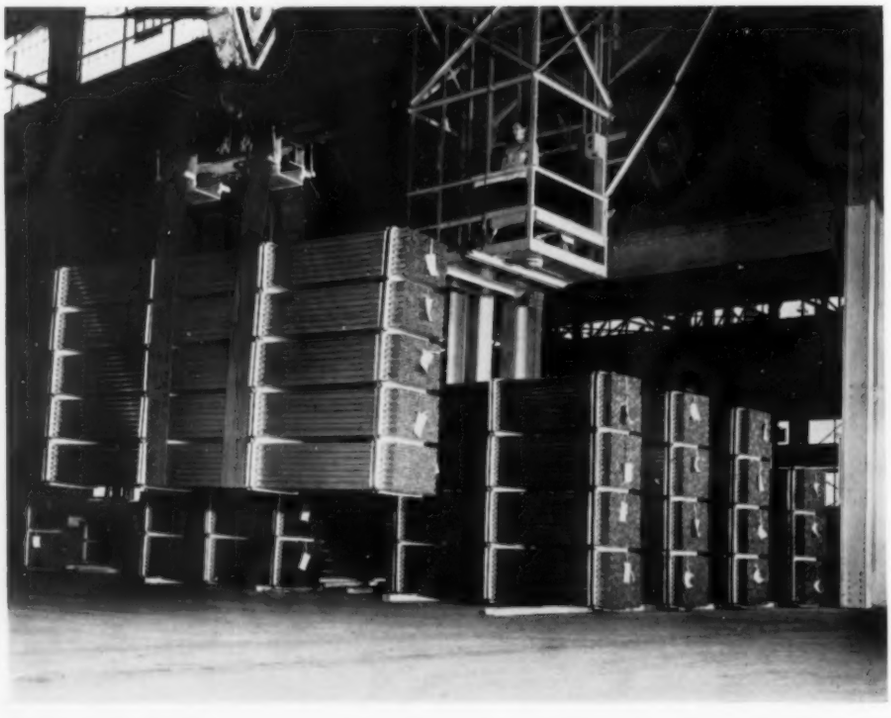


Figure 2 — Light weight of pipe produced on the new welded tube mills at Aluminum Company of America's Alcoa (Tenn.) works is here demonstrated.

Figure 1 — Some of the first welded tube produced on the two new welded tube mills at Aluminum Co. of America's Alcoa (Tenn.) works is shown being prepared for shipping. The tube shown is Alcoa Type 1 welded furniture tube.

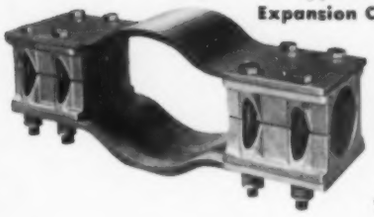


The operation of the new welded tube mills is continuous and begins as a coil of aluminum strip is fed into levelling rolls which flatten it before it is formed and welded. The strip is roll-formed into a tubular shape after edge trimming and passes through a short inductor coil where the unjoined edges of the pipe are fused together by induction welding.

With the addition of the new welded tube mills, Alcoa is able to produce either extruded, drawn, or welded aluminum tube and pipe. This provides a full variety of product to meet most specific customer needs.

The mechanical properties of welded tube are approximately the same as those for the drawn and extruded products where the same alloys are used. The tolerances, including wall thickness, are superior to extruded tube and approximately equal to drawn tube.

The welded tube mills provide an efficient method for production of Alclad aluminum pipe and tube with cladding on both inner and outer surfaces.



Type "PXPL"
Expansion Connector

Type "TU"
T-Connector

Type "FTE"
Angle T-Connector

Type "SL"
Stud Connector

Type "FTU"
T-Connector

DELTA-STAR'S new, complete Power Connector Catalog

Offering power connectors for every application—for use with copper and aluminum conductors

Whatever your connector needs may be, this new Power Connector Catalog has the proper fitting listed.

The catalog is compiled in ten sections. It includes an extensive Data Section to assist you in estimating, planning and engineering for future requirements. This section also contains tables, charts, technical articles and much additional information for every-day engineering use.

Other sections present tubing to tubing connectors, cable to cable, tubing to cable, tube or cable to bar, square tubing, flexible connectors, grounding and stud connectors, and terminal lugs.

A copy of this new DELTA-STAR Power Connector Catalog is yours for the asking. A letter on your company stationery to the factory or nearest Delta-Star representative, will assure your receiving a copy.

Delta-Star Power Connectors Meet Rigid Service Requirements

The cast-to-size connector principle, pioneered by Delta-Star, provides exceptional gripping action and assures positive electrical connection. Use of strong alloys and large bolts contribute to connector life. Simplified design assures ease of installation.

DELTA-STAR ELECTRIC DIVISION

A DIVISION OF HKP
H. K. PORTER COMPANY, INC.

H. K. PORTER COMPANY, INC.
OF PITTSBURGH
2437 Fulton Street • Chicago 12, Illinois
District Offices in Principal Cities

Name Your Flow Metering Problem . . .

Here's the Solution!

Difficult metering jobs — formerly so "impossible" to maintain as to be abandoned or not even attempted — have proved to be successful routine operations with the Foxboro d/p Cell. Here are just a few typical examples:

CORROSION

Corrosive fluids such as fuming nitric acid, SO_2 and dry Cl_2 can be handled without seals or purges, by the all-316 stainless steel construction of the d/p Cell. For materials which attack 316 stainless steel, the negligible displacement (3cc) of the d/p Cell permits use of liquid seals without seal pots, or loss of seal fluid due to pumping. Successful installations include mercury sealing of anhydrous HF, and oil sealing of 30% H_2SO_4.

FREEZING

Flowing fluids that freeze at ambient temperatures can be metered without difficulty by the d/p Cell. Its unique construction permits simple steam tracing or electric heating of the cell body and meter leads to maintain fluid conditions. Accurate metering of naphthalene for ratio flow control with oxygen in the production of phthalic anhydride is typical of numerous services for which d/p Cells are currently employed.

SLURRIES

Most slurries can be metered directly in the d/p Cell. For the more concentrated types, a small liquid purge (one liter per hour) maintains the cell free of deposit. Lime and phosphate slurries and 4½% paper pulp are typical of many materials now being handled.

COAGULATION

Plugging of meter lines by materials that coagulate or polymerize is held to a minimum by the small displacement of the d/p Cell. On synthetic rubber latex, for example, reliable metering has been obtained; production downtime for instrument maintenance has been practically eliminated; and routine clean-out time has been reduced 87%! (Details given in Rubber Reserve report available from Foxboro.)

For your simple, "everyday" jobs of metering steam, water, hydrocarbon and other common fluids, the d/p Cell offers equally important advantages. Its light weight and simple piping make installation easy and economical . . . its sturdy, simple design practically eliminates maintenance. Write for detailed information on the d/p Cell or its application to your particular problem.

THE FOXBORO COMPANY, 584 NEPONSET AVE., FOXBORO, MASS., U.S.A.

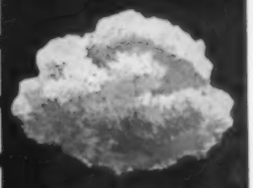
FOXBORO REG. U.S. PAT. OFF.

d/p Cell Flow Transmitter

FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

Let this be your eyes...

...where it's too hot



...behind dangerous barriers

...inaccessible locations

where you can't get close!

In more and more steel plants, power stations, and other industries, RCA Closed-Circuit Television is performing jobs that save thousands of dollars annually by preventing injury to personnel, lost time, or damage to products.

In the comfort of your office or enclosed control booth, your Industrial TV monitor can bring you a clear, high-resolution picture of all the information you need. The camera gets up close and stays continually on the job without attention. It looks in furnaces and boilers, follows processes, reads instruments, and provides control of many other functions that help protect your company's profits.

Engineered to your own particular requirements, RCA Industrial TV can be furnished with special housings and water-cooled windows to make it suitable to the most rugged conditions. And the RCA Service Company makes installation and service available wherever you are. Why not find out more today about the benefits you can obtain from RCA Industrial TV?

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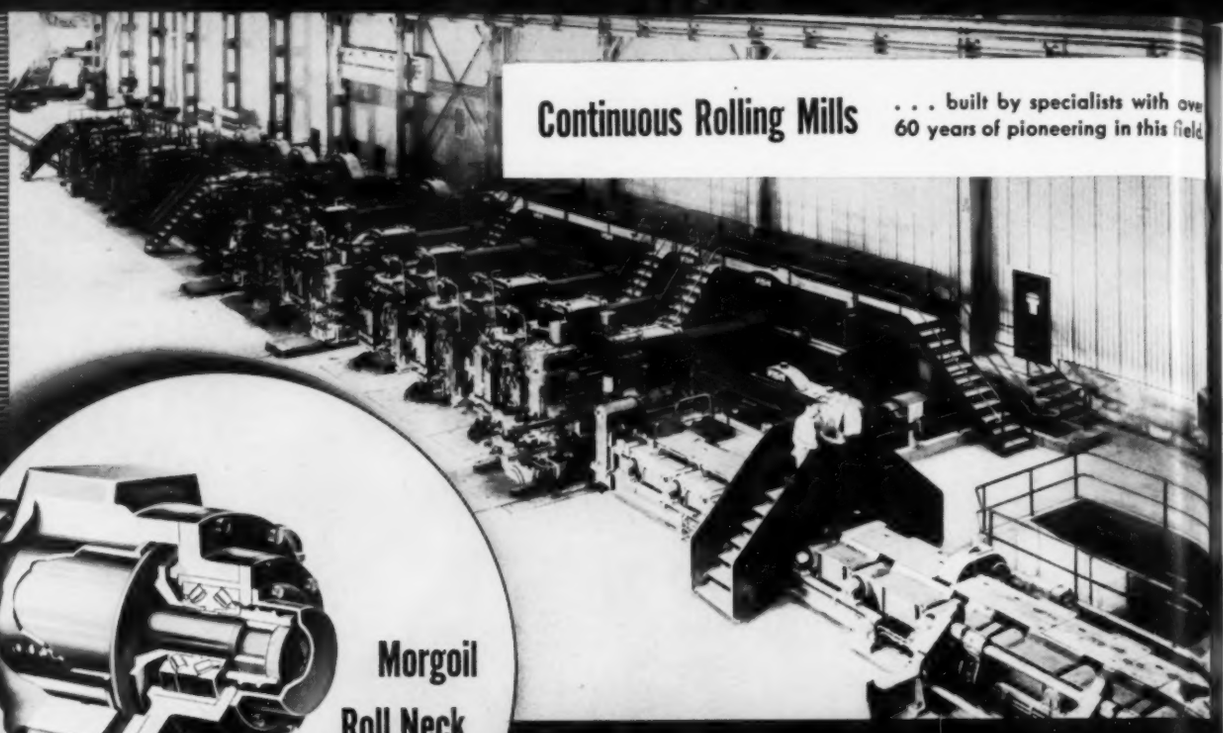
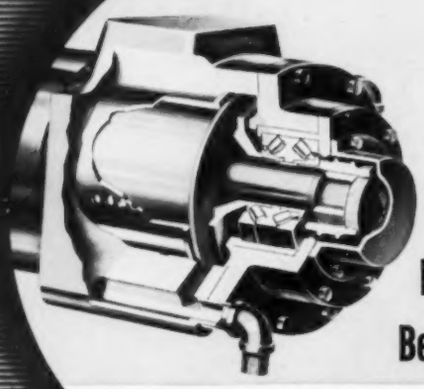


Continuous Rolling Mills . . . built by specialists with over 60 years of pioneering in this field



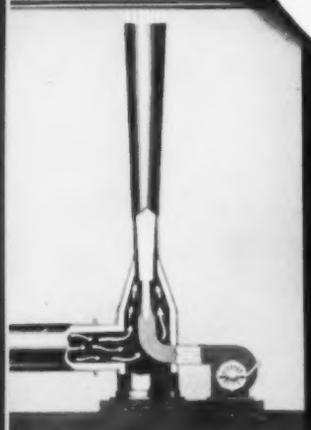
Morgoil Roll Neck Bearings

. . . will increase the accuracy of your product and save on operating and maintenance costs.

MORGAN WORCESTER

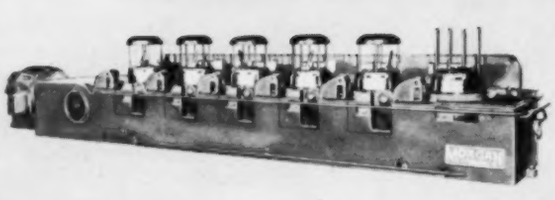
Can help you produce more and better steel products

G-2

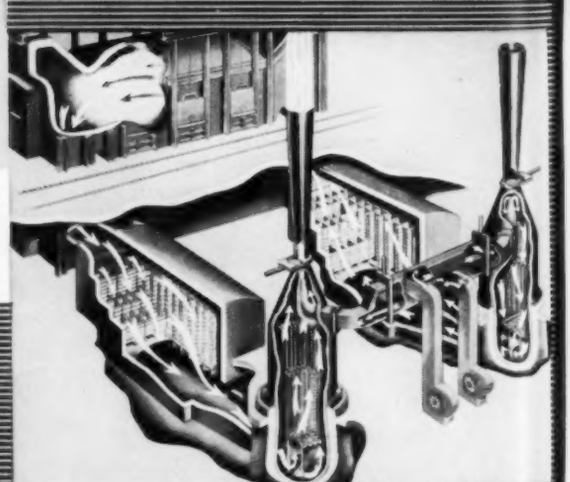


Morgan Ejectors

. . efficiently handle hot gases and fumes as high as 3000° F.



Wire Machines . . . Morgan-Connors give high production, with low die cost, low power cost, low space requirement.



Furnace Control System

. . . Morgan-Isley increases efficiency of any regenerative furnace at relatively low installed cost.

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WORCESTER, MASSACHUSETTS

Rolling Mills - Morgoil Bearings - Wire Mills
Regenerative Furnace Control - Ejectors - Gas Producers

English Representative
International Construction Co., 56 Kingsway, London, W. C. 2, England

Date-line Diary...

March 1

▲ Pittsburgh Coke and Chemical Co. reported net earnings of $1,084,000 or $0.71 a share on gross income of $36,064,000 in 1954 compared with net earnings of $2,855,000 or $2.63 a share on gross sales of $52,212,000 in 1953.

March 3

▲ CIO Steelworkers have announced they will put off the drive for a guaranteed annual wage for one year and will abide by their 1955 contract which provides for bargaining on pay rates only.

▲ According to the AISI, shipments of finished steel products in January were 6,009,958 net tons which was 561,309 tons more than shipped in December 1954.

▲ Reynolds Metals Co. made a net profit after taxes, of $20,280,908 for the year 1954 equal to $10.09 per share on the 2,009,753 shares of stock compared with a profit of $18,320,975 for the year 1953 equal to $9.10 on the same number of stock shares. Net sales of the company reached a record high of $306,778,822 in 1954 compared with $287,892,987 in 1953.

March 4

▲U. S. Steel Corp. announced that current mill price bases for electrolytic and hot dipped tin plate, black plate and terne plate will continue for the period April 1 through September 30, 1955.

▲ Auto production this year is expected to reach the highest peak in history with an estimated figure of 7,500,000 vehicles.

March 5

▲ Babcock and Wilcox has been awarded the contract to build the atomic reactor for the Consolidated Edison Co.'s Peekskill, N. Y. power plant providing it receives approval of the AEC.

▲ The F. W. Dodge Corp. reports contract awards for future construction in the 37 states east of the Rockies in February totaled $1,581,143,000, 29 per cent above February 1954 and 5 per cent above the previous month. The combined January-February figure was the highest ever for the two months at $3,085,593,000.

March 7

▲ CIO International Union of Electrical Workers set a policy that automation benefits should be shared with the worker and this calls for reductions in the work week without pay cuts and provision against layoffs by a guaranteed annual wage.

▲ The Ford car won the 1954 sales race over Chevrolet based on cars sold to customers.

March 8

▲ The Commerce Dept. has tightened its control on issuance of export licenses for iron and steel scrap which is now being exported at a rate of 300,000 tons a month. New licenses will be granted on a cargo-for-cargo basis by allowing one license with each shipment.

▲ A report of the AISI showed hourly payroll cost of wage earners in the iron and steel industry during January averaged $2.392 compared with $2.372 in December and $2.333 for the year 1954. Working hours averaged 37.8 per week in January, 38.0 hr in December and 36.1 for the year 1954. Estimated total employment in January was 602,400 and total payroll to wage and salary employees was estimated at $257,936,000 in January compared to $262,189,000 in December.

March 9

▲ Construction outlays set a new high in February with an estimated cost of $2,636,000,000 by the Commerce and Labor Depts. which was 12 per cent above February 1954.

▲ Stocks broke under heavy selling with Dow-Jones industrials declining 7.71 and rails dropping 3.61 points.

March 10

▲ According to the AISI, finished steel shipped from mills to the automotive industry in January totaled 1,559,774 tons or 111,668 tons more than was shipped to that industry during the previous month.

▲ The Aluminum Association reported primary production of aluminum in January 1955 totaled 256,406,748 lb compared with 254,069,331 lb in December 1954 and 232,493,207 lb in January 1954.

▲ The Government reported unemployment rose 36,000 in February to reach a total of 3,383,000. However, this was 288,000 less than in February 1954.

March 11

▲ Sales of manufacturers, wholesalers and retailers in January amounted to $46,200,000,000 up $2,800,000,000 from the year-earlier level, but $6,100,000,000 below December. Business inventories at the end of January were valued at $76,800,000,00C.

March 14

▲ The Aluminum Association reported primary production of aluminum in February 1955 totaled 232,471,961 lb compared with 256,406,748 lb in January and 220,965,786 lb in February one year ago.

▲ The AISI reports that operating rate of the steel industry for the week of March 14 was scheduled at 92.5 per cent of capacity. This is equivalent to 2,232,000 tons compared with 2,241,000 tons one week ago and 1,613,000 tons one year ago. Index of production for the week is 138.9.

▲ Jones and Laughlin Steel Corp. reported dollar sales amounting to $492,941,000 in 1954 compared with $624,387,000 in 1953, net income after preferred dividends were $25,032,000 or $3.80 a share of common stock in 1954 compared with $31,015,000 or $4.77 a share of common stock in 1953.

▲ Consumption of ferrous scrap during January totaled 5,414,000 tons in comparison with 5,075,563 gross tons during the previous month.

March 15

▲ In their annual report, the International Nickel Co. of Canada, Ltd. announced 1954's net earnings were $65,295,186 or $4.34 per common share on stock compared with 1953's net earnings of $53,694,526 or $3.54 per common share on stock.

▲ The Commerce Dept. and the Securities and Exchange Commission predicts an upward trend in corporate spending during the next three months, a reverse of the drop in the previous three months.

▲ Alcoa reported 1954 revenues totaled $713,004,925 giving a net income of $46,471,470 or $4.38 per common share of stock compared with the previous year's sales of $711,073,898 and net income of $48,848,094 or $4.71 per common share of stock.

▲ United Engineering and Foundry Co.'s total net sales for 1954 amounted to $58,068,808, a decline of 28 per cent from 1953's net sales of $80,702,298. Net income for 1954 was $3,415,372 or $1.37 per common share in comparison with 1953's net income of $3,806,031 or $1.52 per common share.

March 16

▲ U. S. Steel Corp. announced a 21 per cent decline in ingot production for 1954. Sales were $3,250,369,279 with income of $195,417,611 compared with $3,861,034,728 and $222,087,840 in 1953.

▲ U. S. Senate rejected Democratic proposals to cut personal income taxes and then adopted legislation to extend present corporate income and excise tax rates.

March 17

▲ A merger between Bethlehem Steel Corp. and Youngstown Sheet and Tube Co. will be opposed by the U. S. Justice Dept. as the latter threatened to sue if proceedings for the merger were not halted.

▲ Commerce Dept. reported a rise in commercial exports in January of $160,000,000 over a year ago to $1,082,000,000, but volume was off $107,000,000 from December.

▲ Pittsburgh Steel Co. reported net income for the year ending December 31, 1954 at $2,170,694 or $0.62 per common share on net sales of $124,017,058 in comparison with the previous year's net income of $4,648,195 or $2.41 per common share on net sales of $140,716,502.

March 18

▲ Four new developments in the atomic energy field are being planned: a plant to make nuclear power equipment by Combustion Engineering, Inc.; an atomic reactor to be built by Nuclear Metals, Inc.; a laboratory to explore radioactive material by Liberty Mutual Insurance Co.; and a contract given to Tennessee Curtiss-Wright Corp. for studies of atomic power use in aircraft propulsion.

▲ The ARCI reported deliveries of new domestic freight cars in February totaled 2,422 compared with 2,008 in January and 3,974 in February 1954. Orders in February totaled 2,690 cars, leaving a backlog of cars on order as of March of 18,663 compared with 18,395 on February 1.

March 19

▲ Wheeling Steel Corp. reports net profit for the year 1954 after taxes at $9,595,740 or $5.48 per share on total sales and revenues of $190,224,955 in comparison with net profit for the previous year of $12,458,331 or $7.49 per share.

March 21

▲ The AISI reports that operating rate of the steel industry for the week of March 21 is scheduled at 92.8 per cent of capacity. This is equivalent to 2,240,000 tons compared with 2,273,000 tons one week ago and 1,624,000 tons one year ago. Index of production for the week is 139.4.

March 22

▲ Armco reports that in 1954 they earned $41,100,266 or $7.86 per share on sales of $532,045,314.

March 24

▲ National Steel Corp. reported net earnings for 1954 were $30,334,841 equal to $4.12 per common share on total sales of $484,058,380 in comparison with the previous year's net earnings of $49,174,080 equal to $6.68 per common share on total sales of $634,178,060.

▲ A $300,000,000 100-mile long conveyor belt ore and coal hauling project across Ohio, sponsored by the Riverlake Belt Conveyor Lines, Inc., was stopped when the Ohio legislature voted to postpone consideration of the bill.

▲ Republic Steel Corp. will close its ovens in Troy, N. Y. around May 1. This will idle around 175 workers.

March 25

▲ According to the AISC, February 1955 bookings of fabricated structural steel amounted to 230,007 tons compared with 266,594 tons in February 1954. Shipments in February totalled 200,498 tons leaving a backlog of work ahead as of February 28 at 1,360,102 tons.

▲ Sales and operating revenue in 1954 for Republic Steel Corp. amounted to $852,825,669 with a consolidated net income of $52,875,164 or $7.10 per common share compared with 1953's sales of $1,145,103,840 and net income of $56,743,547 or $9.25 per common share.

▲ Machine tool incoming orders in February rose to $62,000,000, up $2,000,000 from January and up 31 per cent over February of last year.

▲ Home building is expected to reach 1,300,000 units in 1955.

▲ General Motors will produce 1,175,000 automobiles and trucks in the first quarter of 1955 which would be 35 per cent above that period one year ago.

▲ Directors of Alcoa voted a 2-to-1 split of its common stock to be effected through a 100 per cent stock dividend.

March 28

▲ Inland Steel Co. reports that the company's stock option plan enabling employees to buy stock shares through payroll savings has been so successful that a similar plan will follow in August.

▲ The AISI reports that operating rate of the steel industry for the week of March 28 is scheduled at 93.6 per cent of capacity. This is equivalent to 2,258,000 tons compared with 2,262,000 tons one week ago and 1,648,000 tons one year ago. Index of production for the week is 140.6.

▲ CIO Auto Workers refused to compromise on its demand for a guaranteed annual wage.

▲ U. S. Steel Corp. plans to close its Ronco Mine in Fayette County, Pa. permanently on June 25 because coal reserves there are almost exhausted.

March 29

▲ Copper was advanced 3¢ per lb to 36¢ by Phelps Dodge and this raise was quickly followed by Anaconda.

▲ Titanium Metals Corp. has cut titanium sponge by 55¢ to $3.95 a lb.

March 30

▲ The CIO United Auto Workers voted in favor of an increase in member dues to $7.50 monthly from $2.50 in order to set up a strike fund of $25,000,000.

March 31

▲ Employment is expected to rise in the next six weeks as 90 per cent of employers in big labor markets plan to increase their working forces by the middle of May according to the labor dept.

▲ Armco has authorized a West Germany company to manufacture silicon steel sheets using Armco methods.

In Steel Mill Processing

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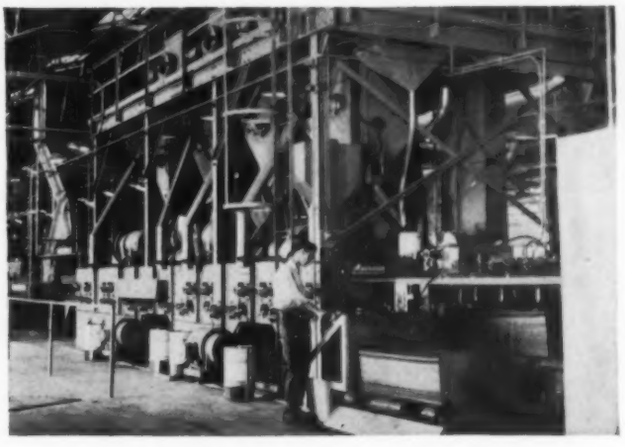
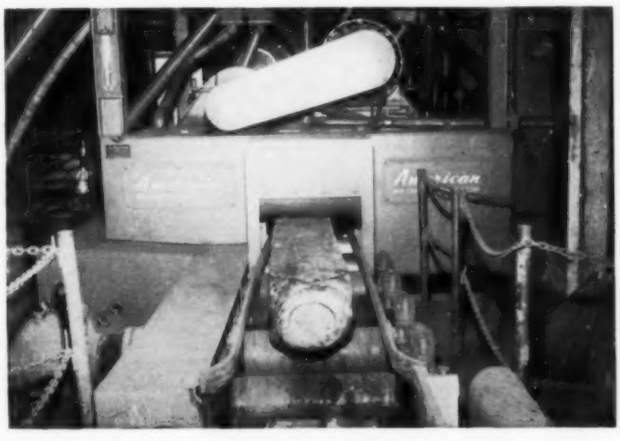
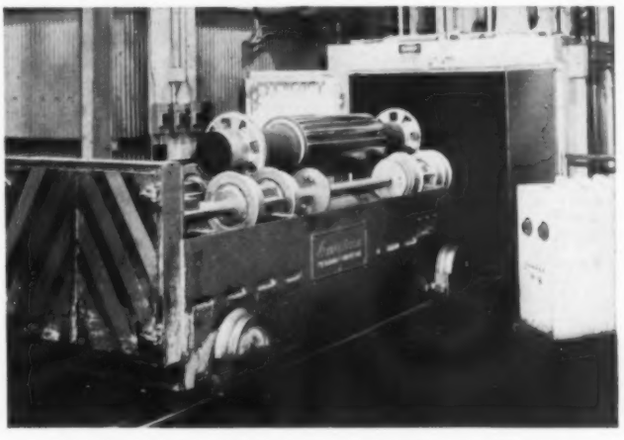
Descaling Strip at Allegheny Ludlum Steel Corp.



Descaling Sheet at Rheem Manufacturing Co.



Descaling Slabs, Billets at Atlas Steel, Ltd.



Etching Mill Rolls at U.S. Steel's Fairless Works

Mechanical descaling with the airless Wheelabrator as an integral unit in steel cleaning lines offers impressive savings in lower production costs for steel producers and fabricators alike.

In descaling steel sheet or strip or etching mill rolls, Wheelabrator's controlled abrasive blast cuts costs in many ways: reduces or eliminates acid pickling; slashes labor costs, crane service and space requirements; improves product quality; adds to equipment life.

More than 60 Wheelabrator installations now descale slabs and billets, continuous carbon strip, sheet steel, bar stock, wire rod and structural steel shapes. They also condition ingot molds and etch mill rolls.

These achievements demonstrate Wheelabrator's leadership and ten years' experience in this field.

Write today for complete information on a Wheelabrator machine for your descaling requirements. Ask, too, for a test demonstration on your own products in our fully equipped laboratory or ask for the name of a plant where you can see the Wheelabrator in operation.

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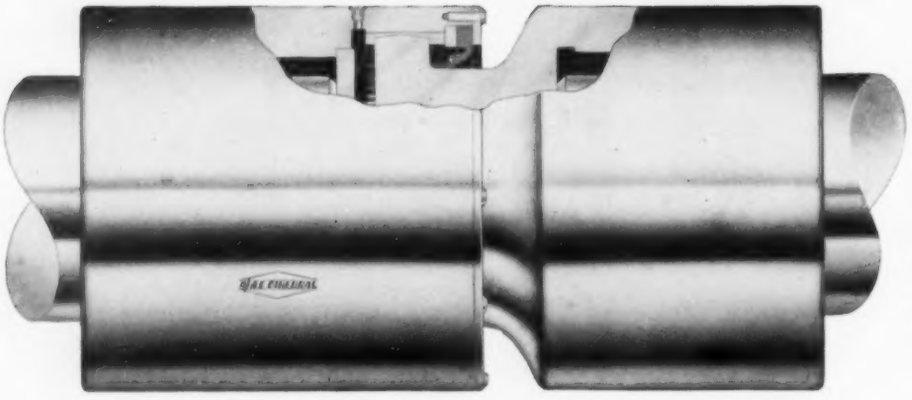

AJAX DIHEDRAL SPINDLE SHAFT COUPLING DESIGN is responsible for long life, trouble-free operation without the usual maintenance on spindle drives between pinion stands and rolls. Tell us your misalignment troubles.

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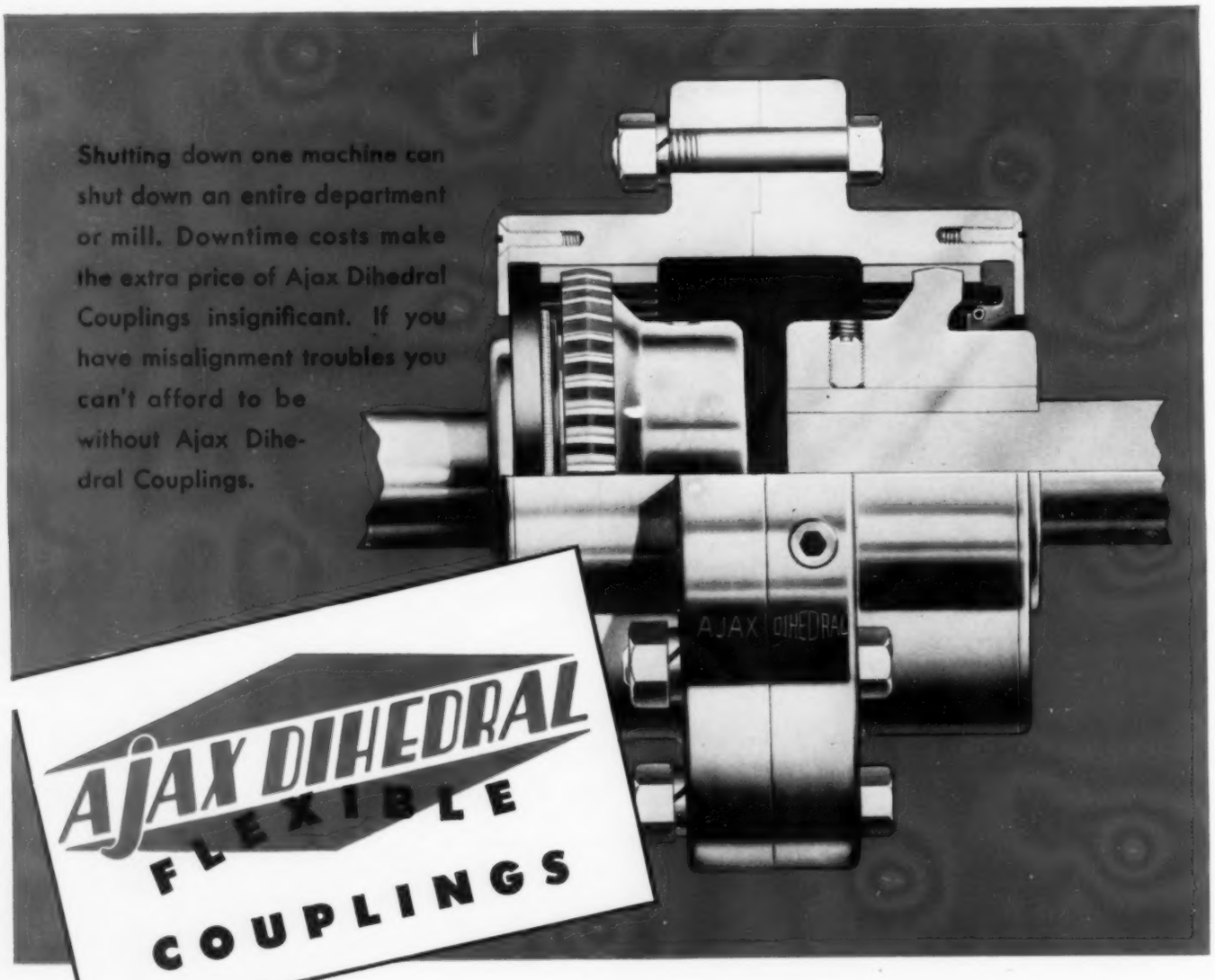

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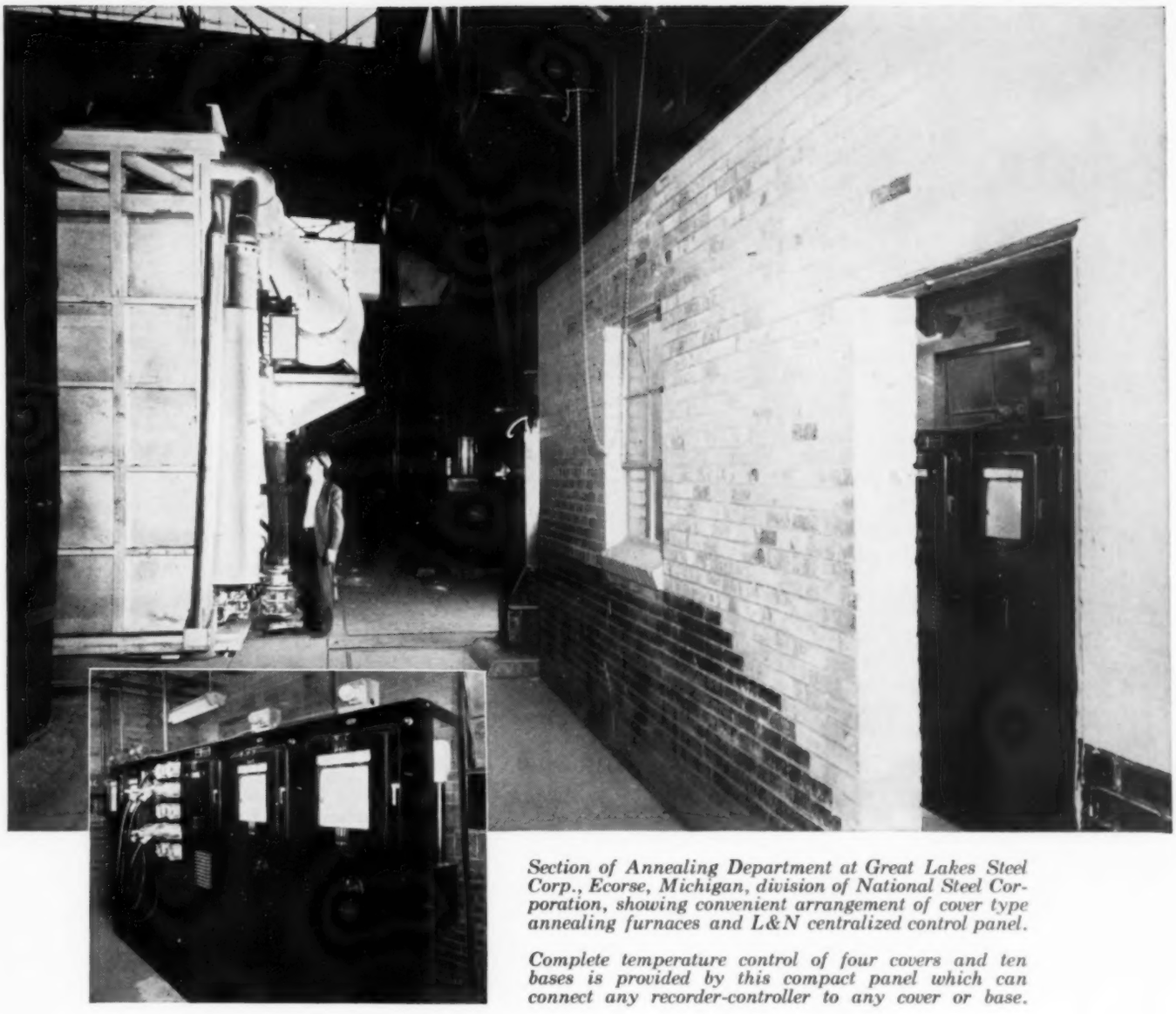

Section of Annealing Department at Great Lakes Steel Corp., Ecorse, Michigan, division of National Steel Corporation, showing convenient arrangement of cover type annealing furnaces and L&N centralized control panel.

Complete temperature control of four covers and ten bases is provided by this compact panel which can connect any recorder-controller to any cover or base.

Here's how Great Lakes Steel gets flexibility into its anneal control

• Great Lakes Steel Corp., Detroit Div. of National Steel Corp., required an individually-engineered control equipment for these big cover type annealing furnaces. At the same time, they insisted on an application of standard instruments, arranged so that any furnace and base could be connected swiftly and easily to any Speedomax controller. And they wanted a temperature "tool" which would carry out all of the operator's decisions in the heating of any product. Here's how L&N did the job.

Temperatures are measured by eight thermocouples in the furnace load and a ninth in the cover. Heating starts with the cover couple in charge . . . switches to one of the load couples when the load control point is approached . . . and stays on this couple during the soak. All temperatures are recorded during the entire cycle. Any thermocouple can be checked in four seconds or less by the high-speed, semi-automatic, Speedomax multiple-point indicator at the center of the panel. Thus the operator retains complete contact with work temperatures even after the cover has been removed.

This control flexibility is a feature of all L&N control panels. It's possible because with us panel assembly begins on the drawing board, where a pattern of control is designed to fill your present and future needs. Every instrument and switch goes on a layout drawing. Every connection is shown on a wiring diagram. Every detail is planned for your benefit, and you receive prints of both drawings, for convenience in maintaining or expanding the control facilities.

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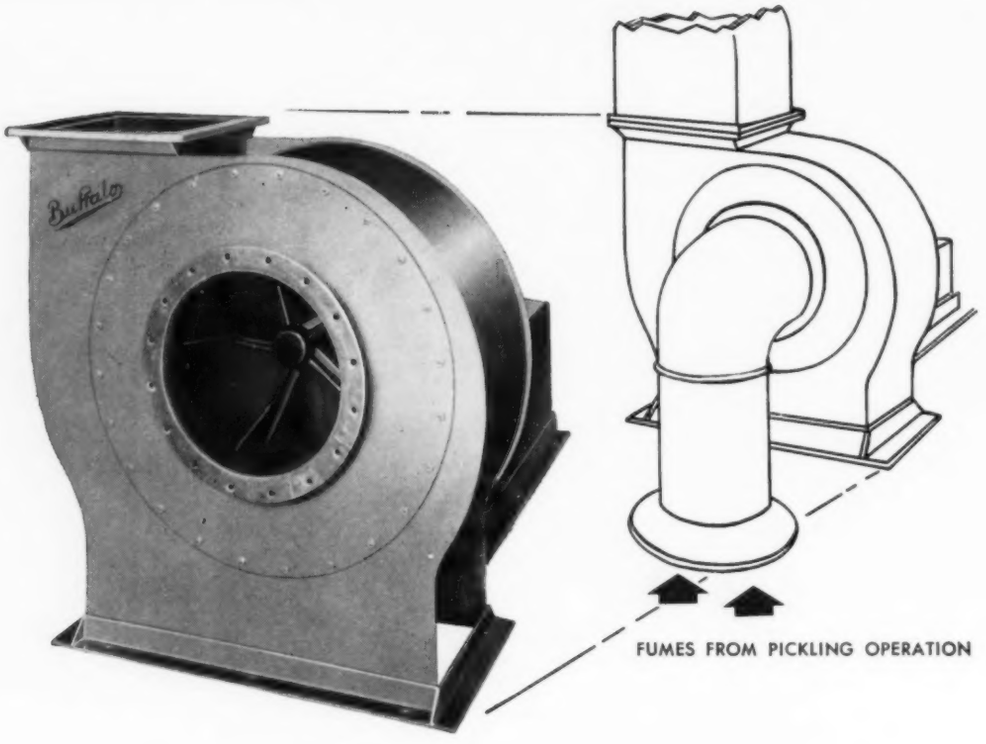
WHY "PICKLE" THE EXHAUST FAN, TOO?



MAKE IT A "BUFFALO" RUBBER-LINED EXHAUSTER AND SAVE REPLACEMENTS

Actually, an ordinary metal exhauster handling pickling fumes is getting a continuous pickling — without rinsing and washing. These fan-eating fumes cause all-too-frequent expenses where they hurt most — in exhauster replacements.

"Buffalo" Rubber-Lined Exhausters are not new — they've been giving 3 to 12 times longer fume-handling service for the past 25 years. Whatever corrosive fume you handle, it never touches metal — because a protective rubber blanket is vulcanized to every square inch of the inside of the fan. "Buffalo" Rubber-Lined Fans more than pay for their extra cost in fan replacements, without beginning to count reduction of down-time. WRITE FOR BULLETIN 2424-E and see the many "plus" features that add up to the famous "Buffalo" "Q" Factor*, or extra value.

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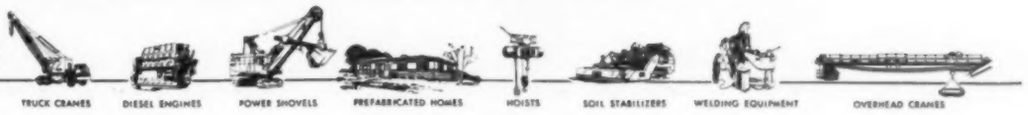

HOT STRIP DESCALING

Thin jets of water strike with tremendous force against sheets of steel. Harmful scale is dislodged, broken up, carried away. The steel passes on—and its producer is assured of higher quality, more accurate gauge and better surface finish.

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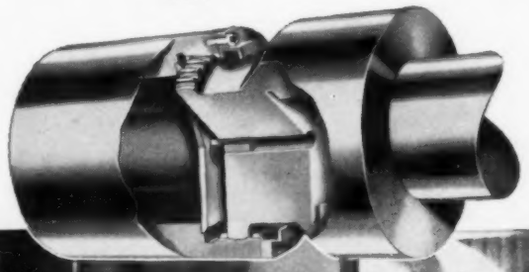

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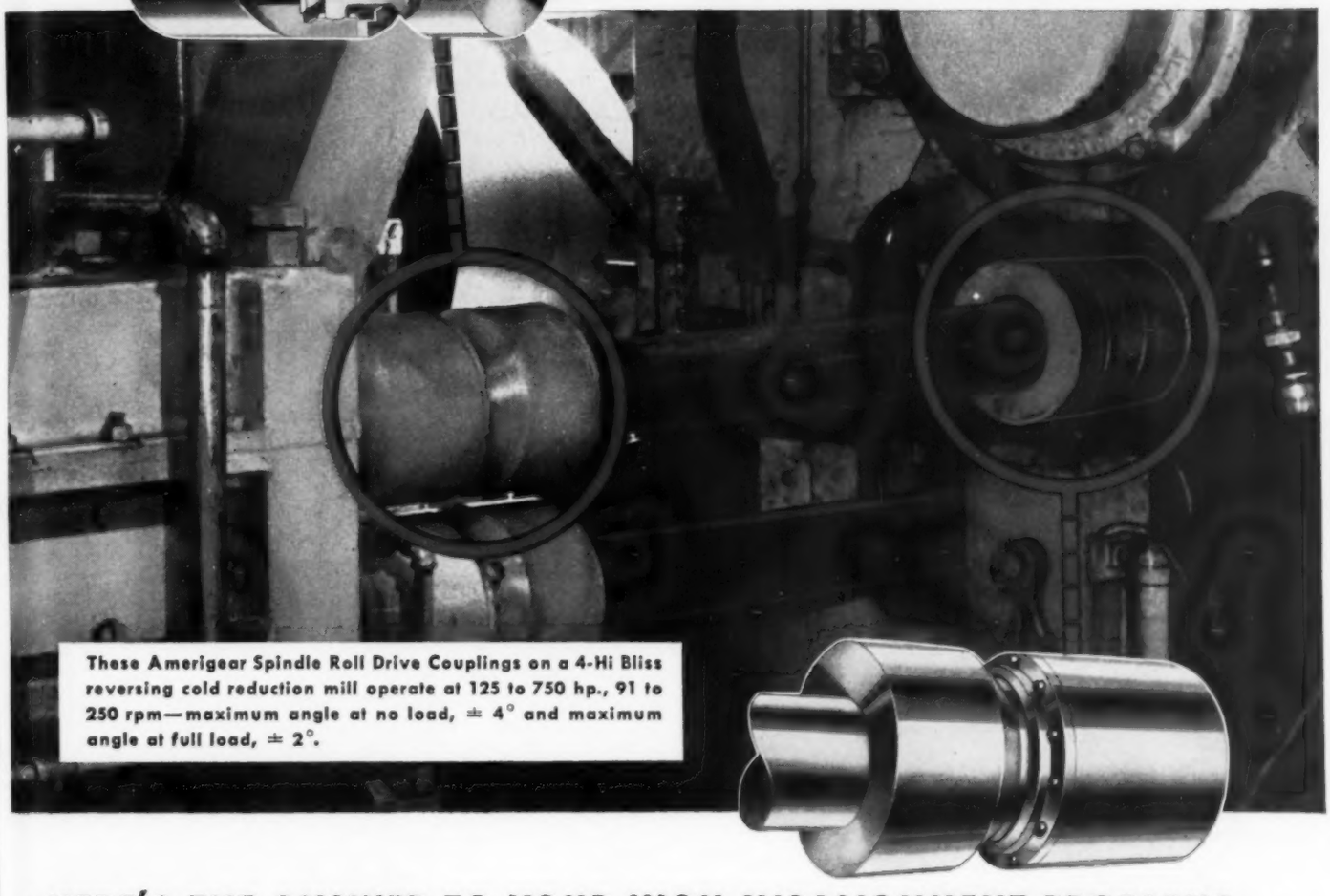

These Amerigear Spindle Roll Drive Couplings on a 4-Hi Bliss reversing cold reduction mill operate at 125 to 750 hp., 91 to 250 rpm—maximum angle at no load, ± 4° and maximum angle at full load, ± 2°.

• HERE'S THE ANSWER TO YOUR HIGH MISALIGNMENT PROBLEMS . . .

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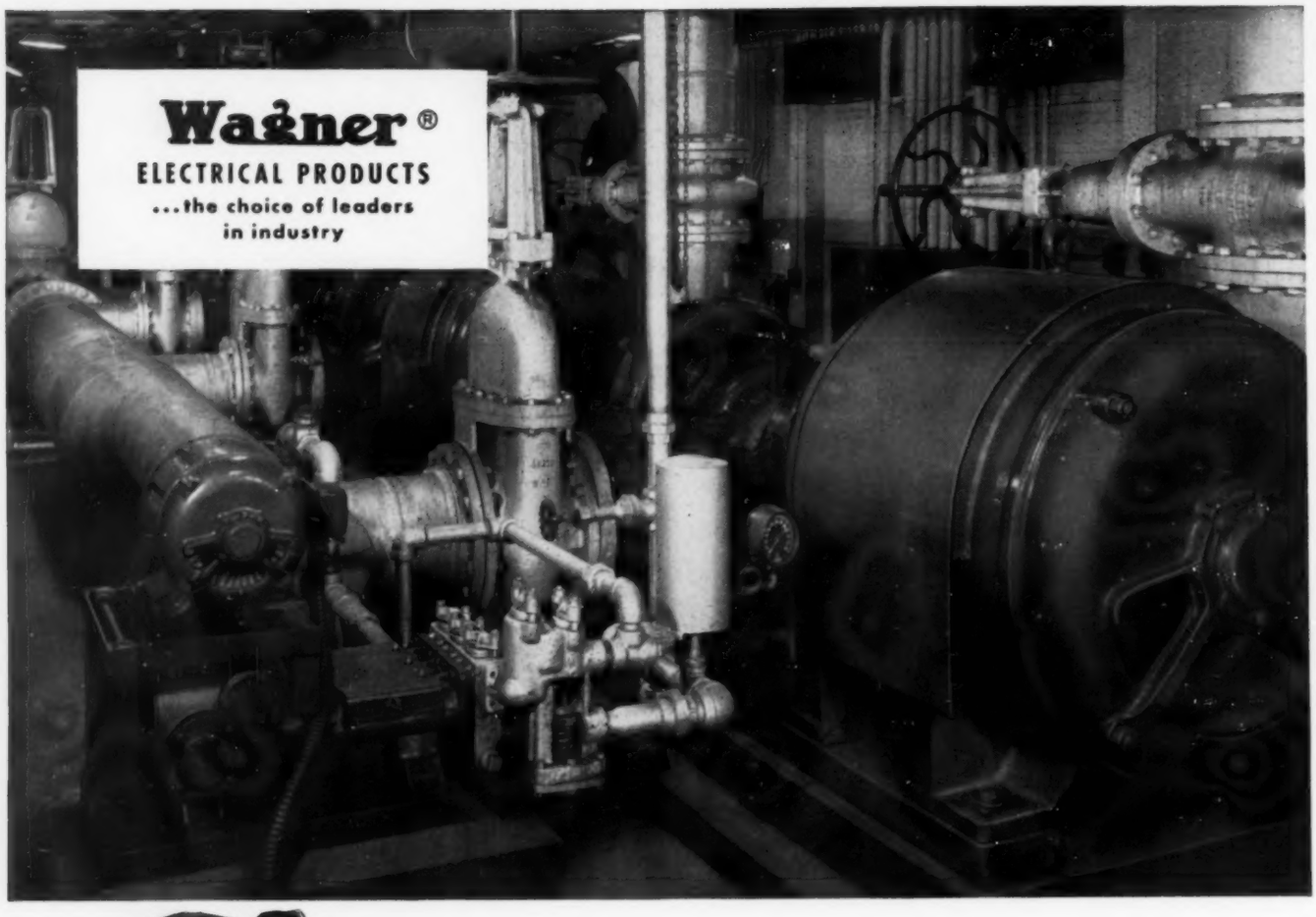

powerful muscles for sinews of steel

In Pennsylvania's Delaware Valley is the largest steel plant ever built at one time. It is the most modern. It is U. S. Steel's Fairless Works.

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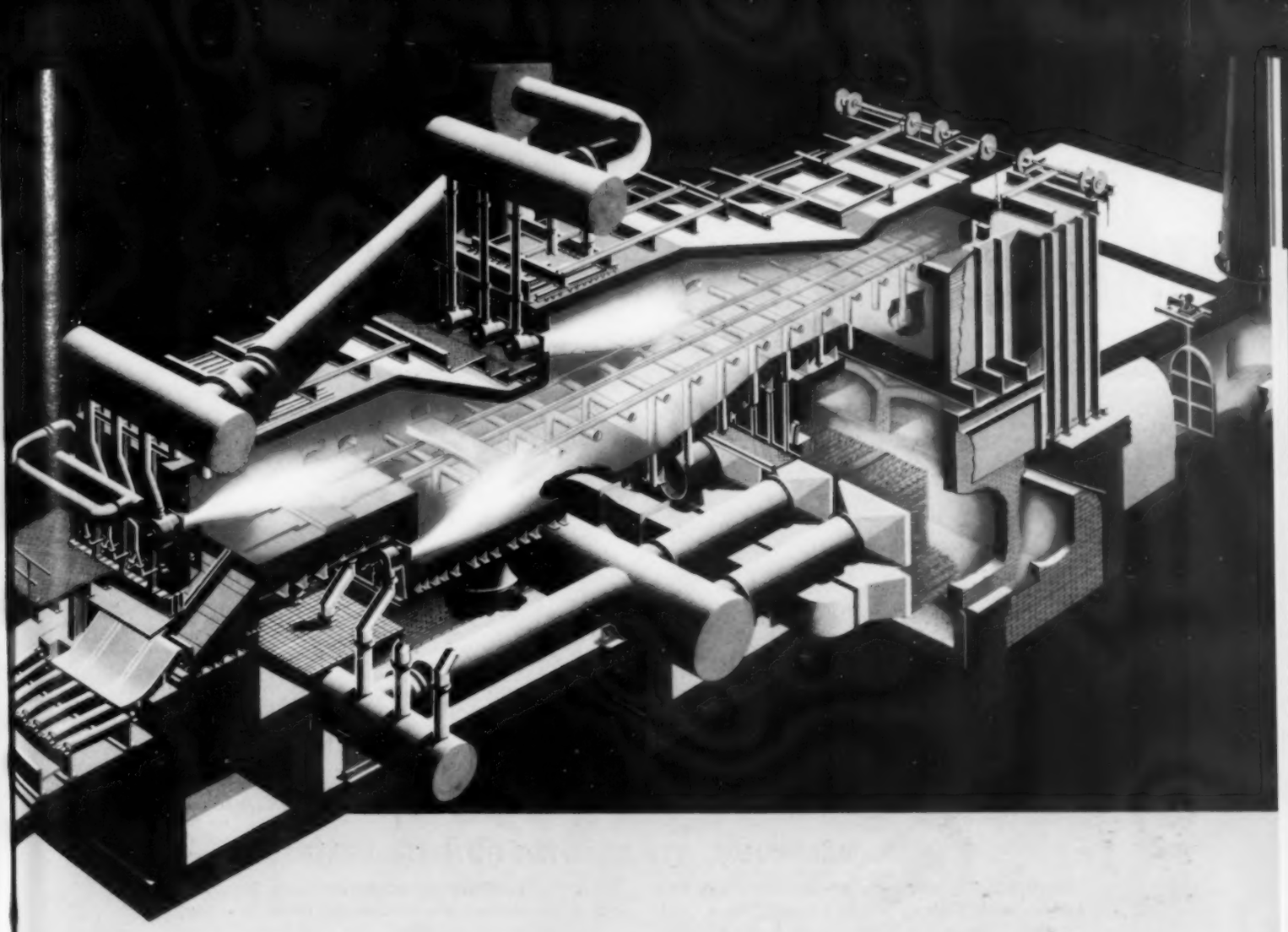

Prime example of Salem-Brosius' furnace-engineering ability

The huge industrial furnace illustrated here attests to the superior engineering skill of Salem-Brosius. One of a few of its kind in the country, it is a pusher-type, triple-fired slab heater currently feeding the giant hot strip and sheet mills of a great steel producer. It features high capacity heating and soaking zones, heavy construction, recuperators for fuel economy, dual gas-oil fuel system, and many other advantages to assure positive, automatic control of furnace output and heating quality. *And the efficiency, economy, ease-of-operation, and trouble-free service this furnace represents are typical of all the furnaces Salem-Brosius builds.* Whether you require conventional heating or heat treating furnaces or furnaces to do an extraordinary job, Salem-Brosius offers equipment designed, engineered, and built not merely as a furnace but as a heating machine. You can purchase these furnaces as complete installations—equipped with all controls, piping and wiring—ready to operate.

Salem-Brosius products—furnaces, forging manipulators, goggle valves, slag granulators, clay guns, charging machines, grab buckets, and special equipment—are engineered for peak performance at lowest cost, because we believe that satisfied customers are our best advertisements. Before you invest in any of these products, we suggest it will pay you to call in a Salem-Brosius engineer and let him study your problem and present a proposal.

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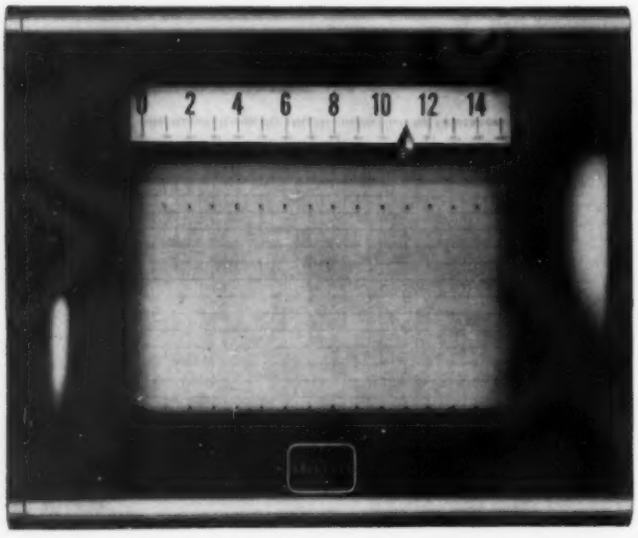

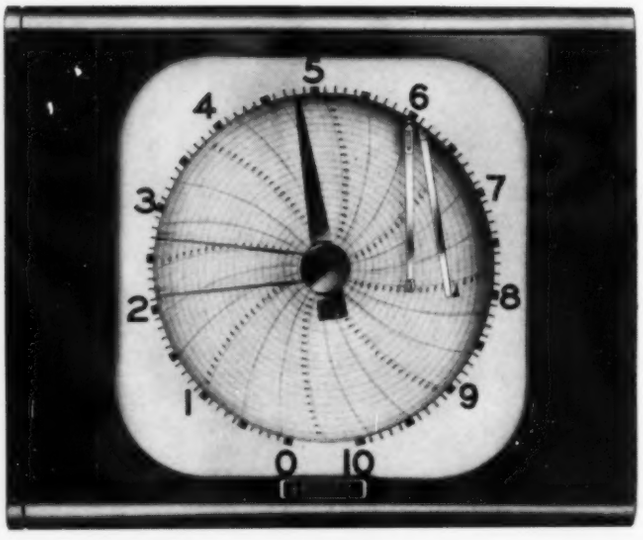

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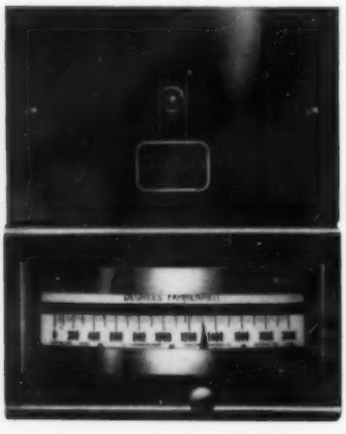

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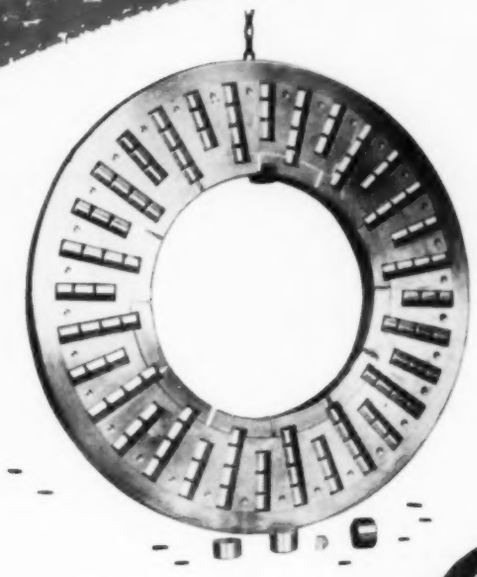

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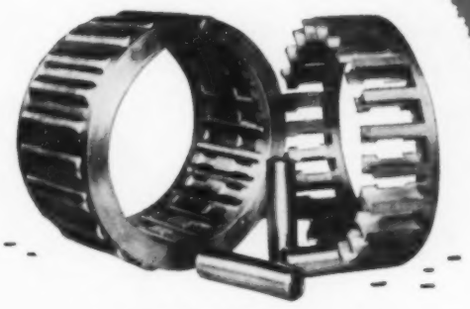

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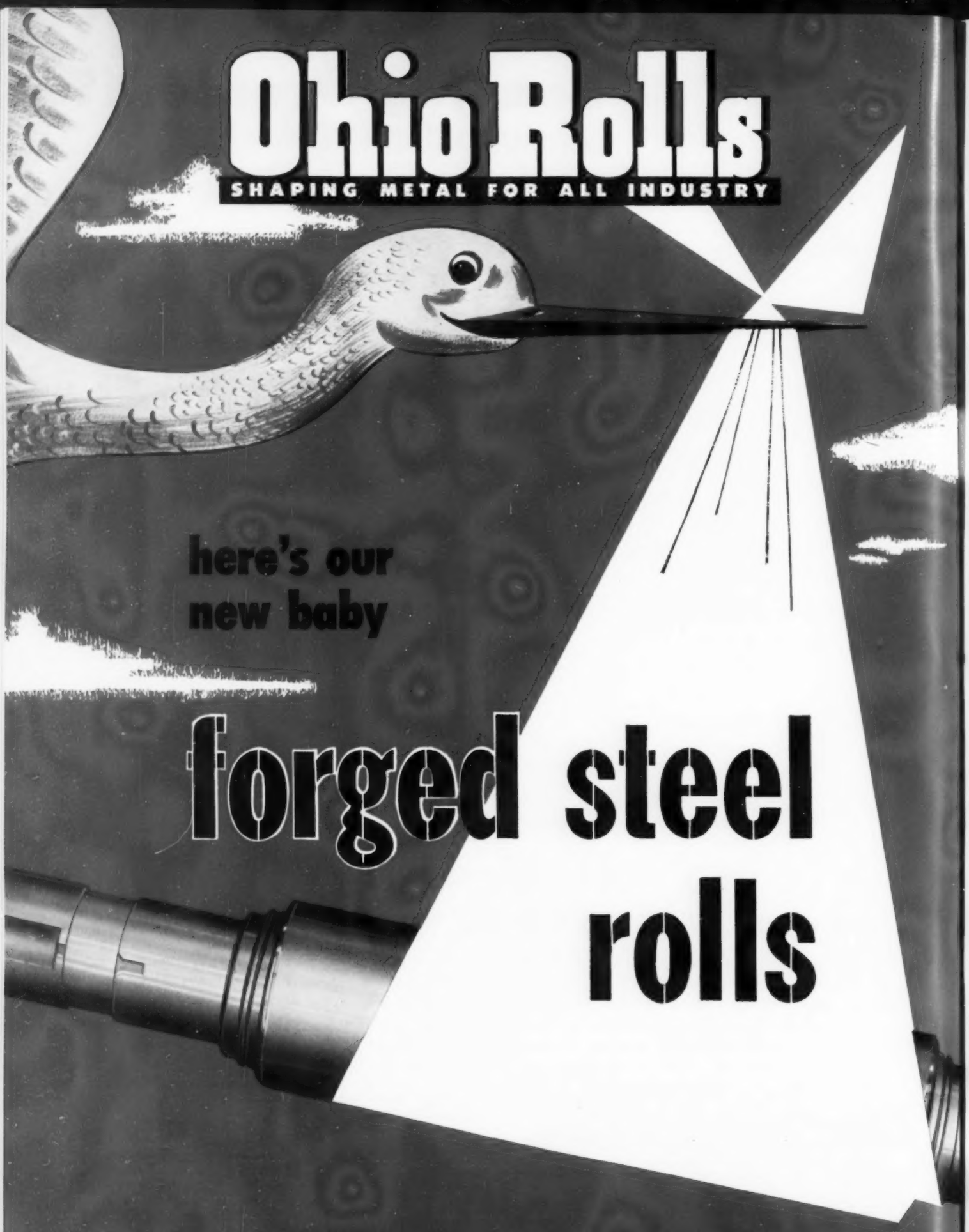

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Industry News...

J&L SUCCESSFULLY PROCESSES MICHIGAN LOW-GRADE IRON ORE AT PILOT PLANT

▲ Successful operation by Jones & Laughlin Steel Corp. of a laboratory-scale pilot plant for processing Michigan low-grade iron ore, has made available a large "new" reserve of iron ore.

Located at J&L's ore research laboratory at Negaunee, Mich., the pilot plant is believed to be the first such plant to demonstrate that Michigan non-magnetic ores can be rendered magnetic and then concentrated by simple magnetic separation.

Plans call for future increase in the scale of development until full-size commercial plants will be able to deliver high-grade concentrate to J&L blast furnaces at Pittsburgh, Aliquippa, Pa., and Cleveland.

This development can play an important role in alleviating the threat of early depletion of iron ore deposits within the United States. There are large reserves of non-magnetic taconite ores, containing about 30 per cent iron. The new continuous process pilot plant at Negaunee is designed to up-grade non-magnetic ores to a usable concentrate containing as much as 63 per cent iron. Slightly more than two tons of Michigan crude taconite are needed to produce one ton of ore concentrate.

Non-magnetic taconite-type ore is a hard, quartz-bearing rock in which iron oxide, known as hematite, is distributed as a fine-grained mineral. One method of separation is to convert the hematite to artificial magnetite, thus permitting the use of magnetic separators.

The solution of the problem of magnetic conversion is provided by a new type of fluidized solids reactor which is in commercial use, principally for roasting sulfide ores. A small-scale model of this reactor is used in J&L's laboratory pilot plant. Operation is on the same principle as the catalytic cracking reactors employed in petroleum refining.

Nonmagnetic Michigan taconite, ground to minus-14 mesh particle size, is chemically reduced to magnetite while suspended in a turbulent stream of hot reducing gas. Accurate temperature control and uniformity of reaction is maintained by the intimate contact of gas with the taconite particles in turbulent motion.

After leaving the furnace, the hot ore is quenched in water. This shock-cooling produces cracks in the ore which facilitate fine-grinding and better separation of iron mineral from the silica after grinding.

Following three successive stages of grinding and magnetic separation, the ore is concentrated to a high-grade fraction containing as much as 63 per cent iron. About half of the original ore is eliminated as a high silica waste product.

In the first concentration step, the minus-14 mesh ore enters a wet magnetic separator where about 20 per cent of the material is discarded as tailings.

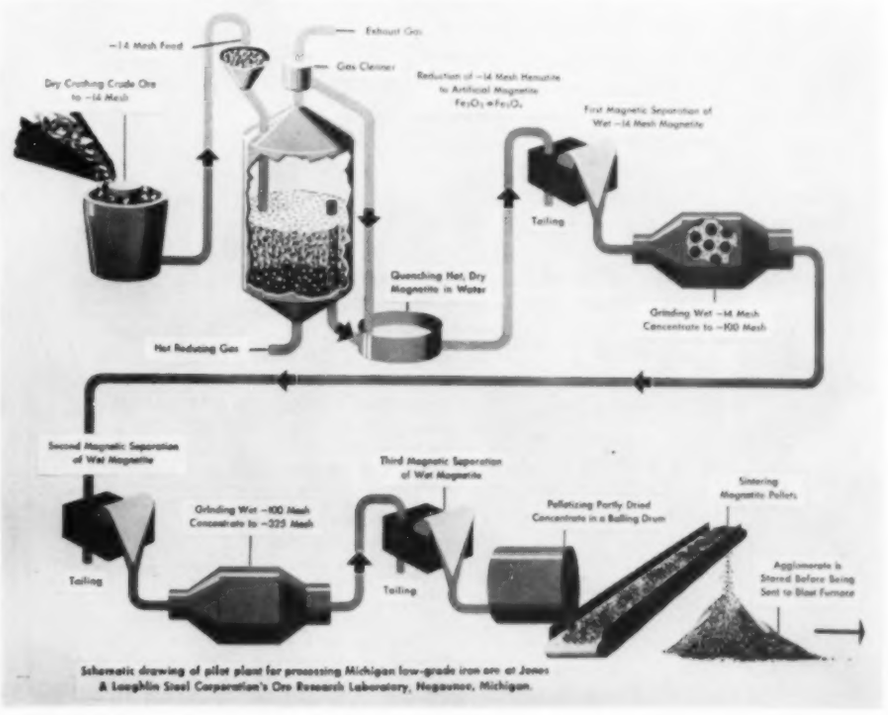
In the second step, the rough concentrate from the previous operation is ground to minus-100 mesh and then subjected to a second magnetic separation process. Here another 20 per cent of the original crude ore is rejected as tailings.

Finally in the third operation, the concentrate remaining, which amounts to 60 per cent by weight of the feed to the plant, is further ground to minus-325 mesh and again treated magnetically to eliminate further the nonmagnetic waste material.

The wet grinding operations described are performed in two successive ball mills. Each mill operates in conjunction with a "classifier." This machine takes the discharge of the grinding mill, separates the material which is sufficiently fine, and sends it on to the magnetic separators, at the same time returning the oversize to the mill for further grinding.

After completion of the concentration steps the water is removed in thickening tanks and by drum filters which extract water by means of vacuum pumps. The final concentrate obtained after three stages of grinding and magnetic separation is too fine to be used in blast furnaces. It is also too fine to be sintered directly by the conventional means. To prepare a suitably coarse feed for

Drawing illustrates operation of J&L's pilot plant. About two tons of crude taconite produces one ton of ore concentrate.


−14 Mesh Feed
Exhaust Gas
Gas Cleaner
Dry Crushing Crude Ore to −14 Mesh
Reduction of −14 Mesh Hematite to Artificial Magnetite $Fe_2O_3 \rightarrow Fe_3O_4$
First Magnetic Separation of Wet −14 Mesh Magnetite
Tailing
Quenching Hot, Dry Magnetite in Water
Grinding Wet −14 Mesh Concentrate to −100 Mesh
Hot Reducing Gas
Second Magnetic Separation of Wet Magnetite
Third Magnetic Separation of Wet Magnetite
Grinding Wet −100 Mesh Concentrate to −325 Mesh
Pelletizing Partly Dried Concentrate in a Balling Drum
Sintering Magnetite Pellets
Tailing
Tailing
Agglomerate is Stored Before Being Sent to Blast Furnace

Schematic drawing of pilot plant for processing Michigan low-grade iron ore at Jones & Laughlin Steel Corporation's Ore Research Laboratory, Negaunee, Michigan.

Ohio Rolls

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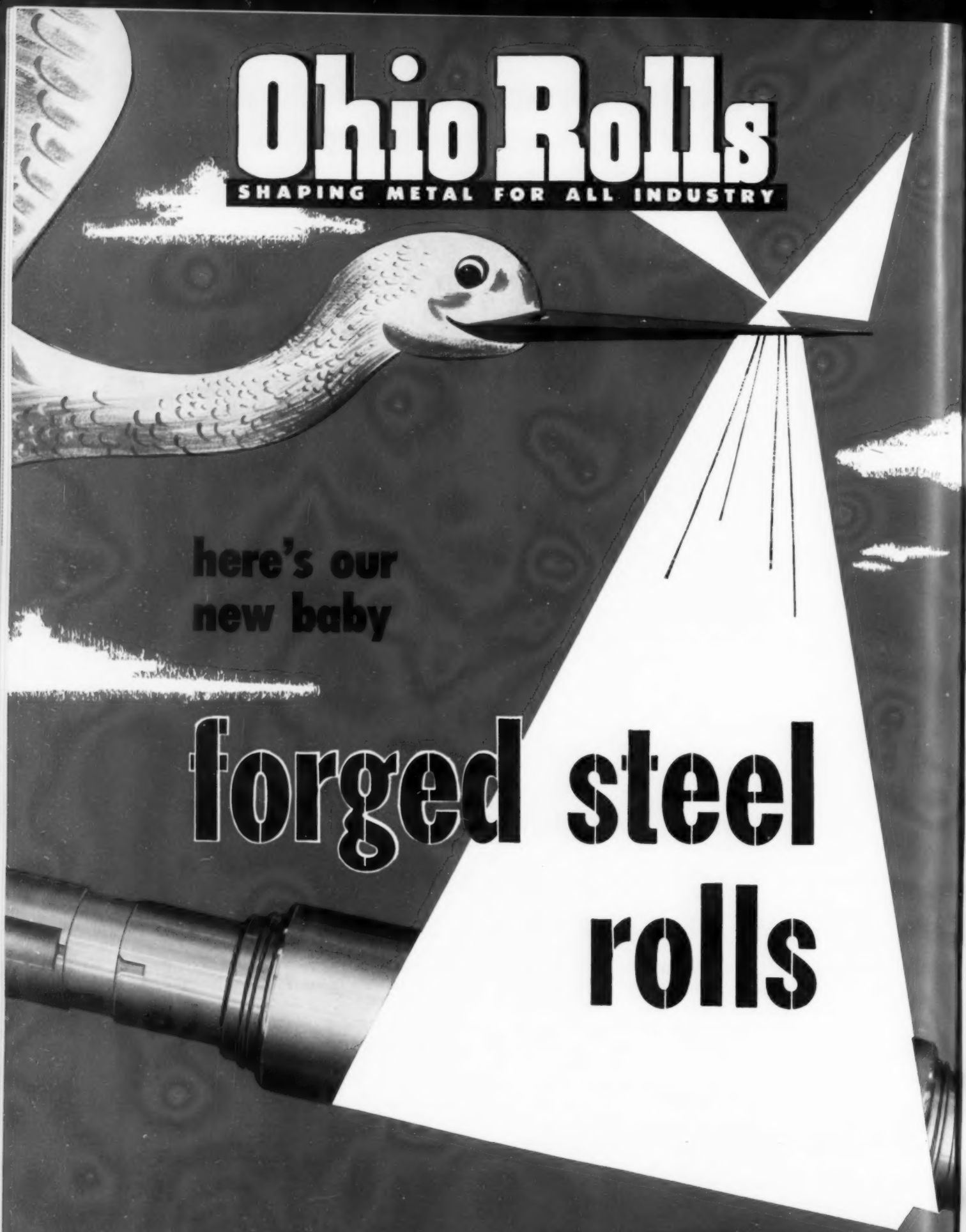

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Industry News...

J&L SUCCESSFULLY PROCESSES MICHIGAN LOW-GRADE IRON ORE AT PILOT PLANT

▲ Successful operation by Jones & Laughlin Steel Corp. of a laboratory-scale pilot plant for processing Michigan low-grade iron ore, has made available a large "new" reserve of iron ore.

Located at J&L's ore research laboratory at Negaunee, Mich., the pilot plant is believed to be the first such plant to demonstrate that Michigan non-magnetic ores can be rendered magnetic and then concentrated by simple magnetic separation.

Plans call for future increase in the scale of development until full-size commercial plants will be able to deliver high-grade concentrate to J&L blast furnaces at Pittsburgh, Aliquippa, Pa., and Cleveland.

This development can play an important role in alleviating the threat of early depletion of iron ore deposits within the United States. There are large reserves of non-magnetic taconite ores, containing about 30 per cent iron. The new continuous process pilot plant at Negaunee is designed to up-grade non-magnetic ores to a usable concentrate containing as much as 63 per cent iron. Slightly more than two tons of Michigan crude taconite are needed to produce one ton of ore concentrate.

Non-magnetic taconite-type ore is a hard, quartz-bearing rock in which iron oxide, known as hematite, is distributed as a fine-grained mineral. One method of separation is to convert the hematite to artificial magnetite, thus permitting the use of magnetic separators.

The solution of the problem of magnetic conversion is provided by a new type of fluidized solids reactor which is in commercial use, principally for roasting sulfide ores. A small-scale model of this reactor is used in J&L's laboratory pilot plant. Operation is on the same principle as the catalytic cracking reactors employed in petroleum refining.

Nonmagnetic Michigan taconite, ground to minus-14 mesh particle size, is chemically reduced to magnetite while suspended in a turbulent stream of hot reducing gas. Accurate temperature control and uniformity of reaction is maintained by the intimate contact of gas with the taconite particles in turbulent motion.

After leaving the furnace, the hot ore is quenched in water. This shock-cooling produces cracks in the ore which facilitate fine-grinding and better separation of iron mineral from the silica after grinding.

Following three successive stages of grinding and magnetic separation, the ore is concentrated to a high-grade fraction containing as much as 63 per cent iron. About half of the original ore is eliminated as a high silica waste product.

In the first concentration step, the minus-14 mesh ore enters a wet magnetic separator where about 20 per cent of the material is discarded as tailings.

In the second step, the rough concentrate from the previous operation is ground to minus-100 mesh and then subjected to a second magnetic separation process. Here another 20 per cent of the original crude ore is rejected as tailings.

Finally in the third operation, the concentrate remaining, which amounts to 60 per cent by weight of the feed to the plant, is further ground to minus-325 mesh and again treated magnetically to eliminate further the nonmagnetic waste material.

The wet grinding operations described are performed in two successive ball mills. Each mill operates in conjunction with a "classifier." This machine takes the discharge of the grinding mill, separates the material which is sufficiently fine, and sends it on to the magnetic separators, at the same time returning the oversize to the mill for further grinding.

After completion of the concentration steps the water is removed in thickening tanks and by drum filters which extract water by means of vacuum pumps. The final concentrate obtained after three stages of grinding and magnetic separation is too fine to be used in blast furnaces. It is also too fine to be sintered directly by the conventional means. To prepare a suitably coarse feed for

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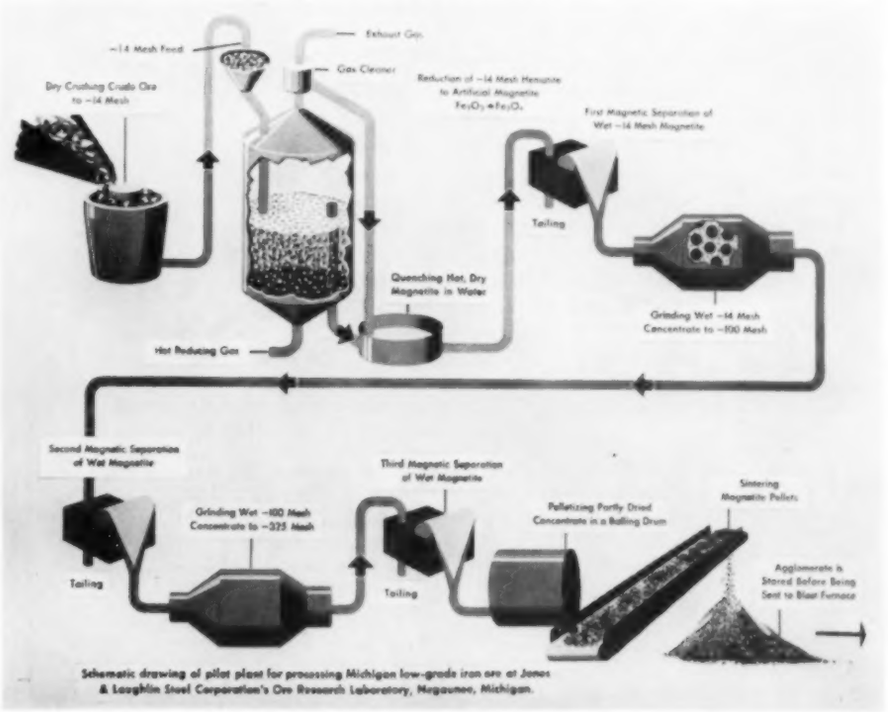
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Schematic drawing of pilot plant for processing Michigan low-grade iron ore at Jones & Laughlin Steel Corporation's Ore Research Laboratory, Negaunee, Michigan.

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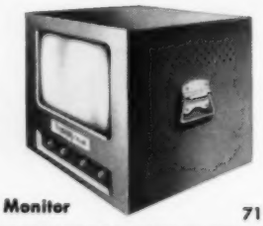

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sintering, J&L has applied pelletizing as the initial agglomerating process. A rotary drum forms the concentrate powder into balls or pellets which can then be hardened on the moving grate of the usual sintering machine. At the same time, the sintering machine consolidates the individual pellets into grape-like clusters.

PROGRAM TO INCREASE SHEET PRODUCTION

▲ Cold rolled sheet production at Great Lakes Steel Corp. will be increased by a minimum of 50,000 tons per month, or 600,000 tons per year, through a program now in progress.

All facilities included in the program will be completed and in operation by the end of 1955, according to an announcement of E. T. Weir, chairman of National Steel Corp. "Our present estimate of a 600,000 ton annual increase in the production of cold rolled sheets is on the conservative side," Mr. Weir stated.

ARMCO EXPANSION PLANS TO COVER THREE PLANTS

▲ Armco Steel Corp. disclosed details of a $60 million expansion and improvement program announced earlier this year.

"We are planning more and better facilities for producing practically all of our grades of sheet and strip steel," Armco president W. W. Sebald said.

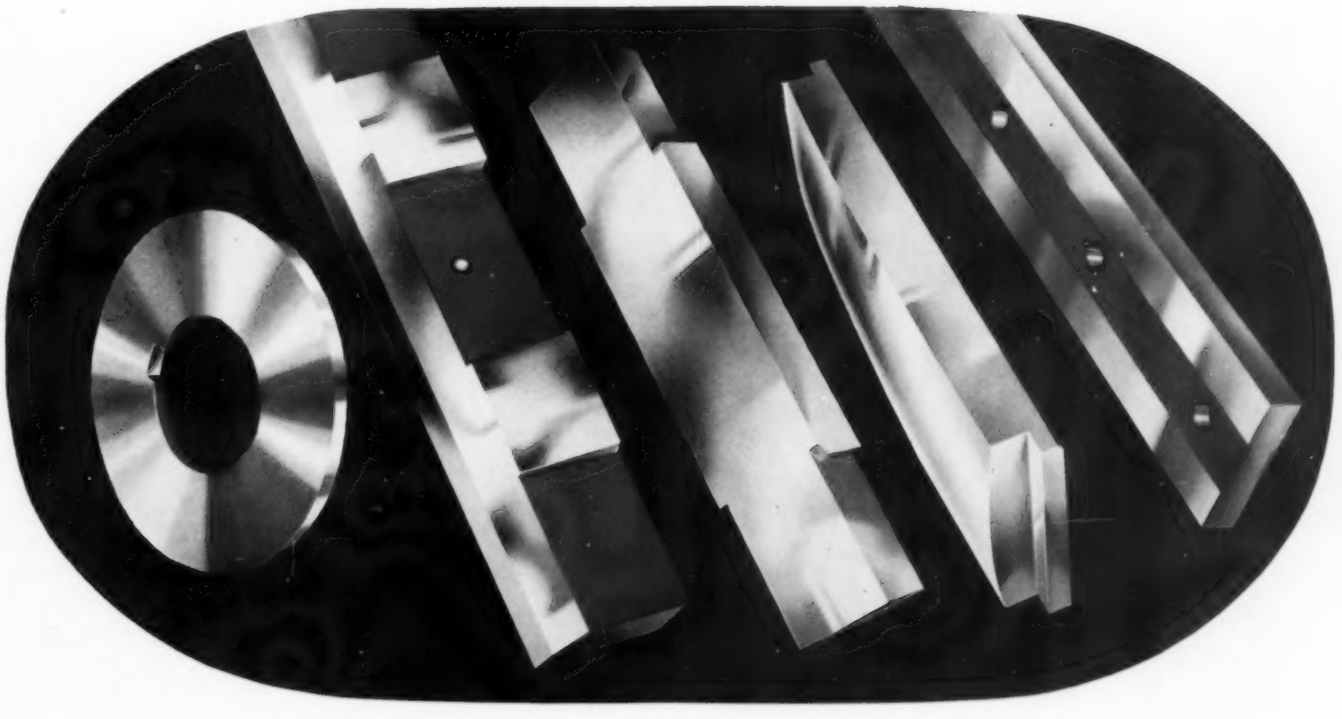
"These additions will be the first steps in a long-range program of expansion and improvement, and will involve important new facilities at our Middletown, Ohio, Ashland, Ky., and Butler, Pa., plants," he said.

Approximately $25 million will be spent at the Butler Works for a new 56-in. hot strip mill, a new annealing and pickling line, widening of the present slabbing mill, and relocation of the company's railroad wheel works there.

A $15 million expenditure at the Ashland Works will include the addition of a second reversing cold mill, a strip normalizing and pickling line, a complete new sintering plant, a new shipping terminal on the Ohio River, and extensive building additions.

At Middletown, Armco plans to spend $18 million. The company will add two 275-ton open hearth furnaces and provide sufficient building space for construction of two additional

always get the OK



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furnaces. The furnaces will be of advanced design and will use Armco's continuous charging method.

A third continuous line for coating steel with zinc or aluminum will also be added at Middletown, joining the two continuous coating lines Armco already has in operation here. Annealing capacity will be enlarged, a new coil temper mill added, and pickling lines and ingot handling facilities will be improved.

Engineering work for all phases of the program has been underway for several months and construction will begin as soon as possible, Mr. Sebald said.

Completion of the program will raise Armco's total steel producing capacity to over 5,300,000 tons of ingots a year.

WESTINGHOUSE FORMS HYDRAULIC DRIVES DEPT.

▲ The Schneider Manufacturing Corp., of Muncie, Ind., a wholly-owned subsidiary of the Westinghouse Electric Corp., has been dissolved to form the hydraulic drives department of the Westinghouse Gearing Division. The Schneider Manufacturing Co. was purchased by Westinghouse in October, 1954.

The hydraulic drives department will sell, engineer, and manufacture hydraulic torque converters and associated brakes and transmissions. Headquarters of the department will remain at Muncie, Ind.

Three key appointments were announced for the new department. They are: S. M. Johns, sales manager; T. P. Dunkin, manager of manufacturing; and P. L. Fosburg, engineering manager.

DIRECTORS APPROVE REPUBLIC EXPANSION

▲ A major expansion program at Republic Steel Corp.'s Gadsden, Ala., plant for the production of hot and cold rolled sheets in coils or cut lengths and continuous galvanized sheets has been approved by the directors.

The new facilities also will stabilize operations at Republic's Gadsden mill which have been sporadic in recent months due to fluctuating demand for large diameter gas transmission pipe, a major product of the plant.

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"we overload them heavily"

"practically nothing for repairs"

"16 hours a day for 20 years"

"20-25% overload regularly"

"23 years in service"

"our first unit still satisfactory"

"rough treatment doesn't hurt it"

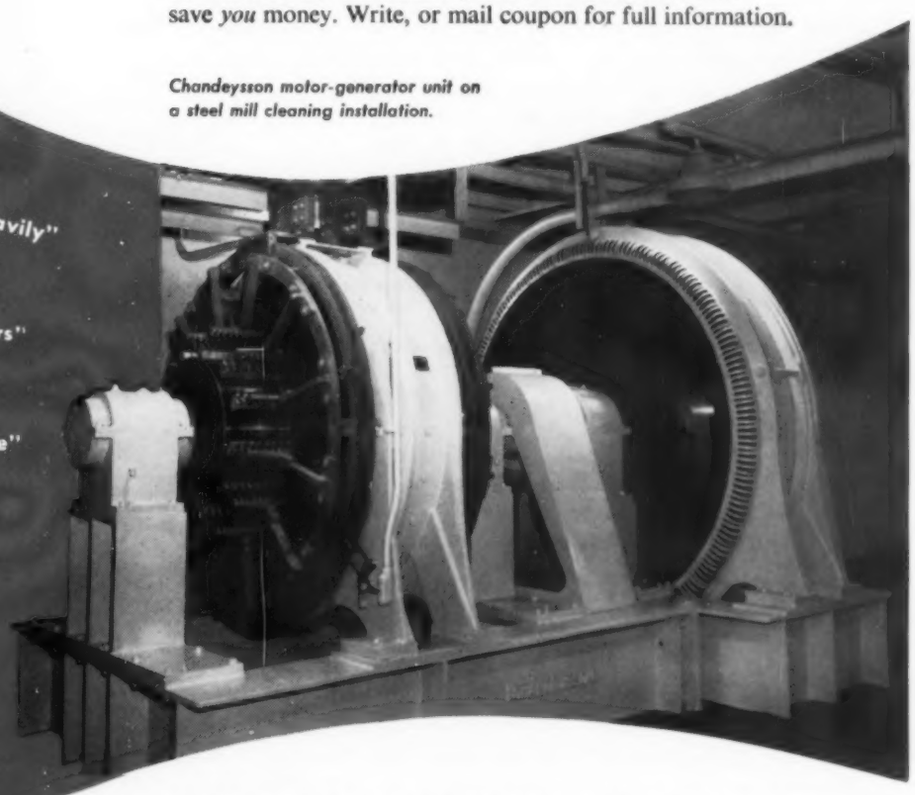
"48 years in service"

"nothing for maintenance"

"in 20 years bought only brushes"

"thoroughly sold on Chandeysson"

Chandeysson motor-generator unit on a steel mill cleaning installation.



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8 good reasons why you should use these ROLLER GUIDES in your bar or wire rod mill

The Morgårdshammar Roller Guides — patented in most countries of industrial importance — are constructed according to the following principles:

1 The entry friction guides are rigidly clamped into the guide box. They are intended to lead the oval to the groove in the roller, to protect the rollers against overloading, and to straighten bent rods.
The groove in the entry guides is made about 1/8" wider than the oval.

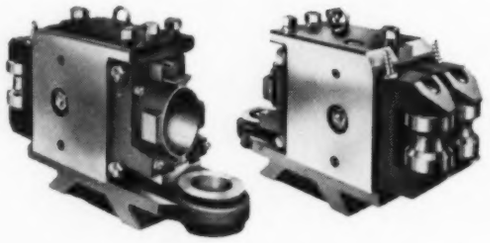
2 The rollers are mounted on laminated springs, which can be adjusted by means of the screws "B", and hold the oval steadily even if there should be some slight variation in the thickness of the oval.

3 If the thickness of the oval should vary, the springs of both rollers yield an equal amount, so that the oval remains in the centre of the groove.

4 To tilt the oval, the screws "A" are adjusted as shown by the arrows. One roller will then be lifted as much as the other is lowered.

5 As the oval is held very rigidly, the leader oval for wire rod may be plump, unless other circumstances call for a thinner oval.

6 The roller guide assemblies are narrow, and all screws that require adjustment during rolling are accessible from the front of the mill. No lateral space outside the guide box is therefore required for gaining access to the set screws, and the guide box assembly can thus be located close to the mill housing.



7 As the groove in the entry guides is wide and nothing but rolling friction acts on the oval, the latter is very easily introduced into the pass, and there is practically no risk of scratching the bar.

8 The roller guide may be used not only for leader and break-down oval passes but also for edging flats as well as for rolling squares, hexagons, octagons and various other sections, for instance in reduction passes for hexagon. It is suitable for all types of rolling mills. An important advantage is that the roller guide enables repeaters to be used in rolling plump leader-ovals.

P.S. Practically speaking, every bar and wire rod mill in Scandinavia uses roller guides of our design.

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installed are the following: A continuous 54-in. hot strip mill; a continuous 54-in. 3-stand tandem cold mill; a 54-in. temper mill; a continuous pickle line; annealing furnaces, finishing, shearing and shipping equipment; and a 48-in. continuous galvanizing line.

This equipment will permit the production of hot and cold rolled sheets and galvanized sheets up to 48-in. in width.

COUPLING FIRM NAMES SALES REPRESENTATIVE

▲ W. J. Bernhart Co., 3041 Bailey Ave., Buffalo, N. Y. has been appointed sales representative for the flexible couplings and allied power transmission products made by American Flexible Coupling Co. and nationally marketed by Amerigear-Zurn, Inc.

The Bernhart organization, headed by William J. Bernhart and associate K. W. Davies, will cover the territory that includes central and western N. Y., and northern Pa.

SHIPS FIRST ORDER OF NEW SEAMLESS PIPE

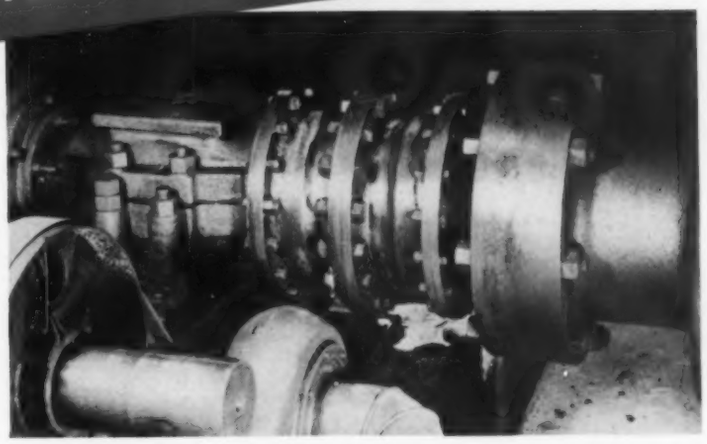
▲ Cold expanded seamless pipe is being shipped from the Lorain Works of U. S. Steel Corp.'s National Tube Division. This shipment is the first commercial order of this new product. Combining high strength and maximum safety, the new expanded seamless pipe will be used in the construction of a 24 in. gas transmission line that will extend across 250 miles of densely populated areas in the eastern United States. Operation of the new expansion unit at Lorain marks the successful completion of a program of continuous research and development. The equipment is designed to expand pipe in the size range of 16-in. to 26-in. outside diameter.

REPUBLIC TO BUILD COKE BATTERY AT MASSILLON

▲ A battery of 31 by-product coke ovens will be built at the Massillon, Ohio, plant of Republic Steel Corp., according to an announcement by Oscar A. Bamberger, Central Alloy district manager.

Also announced were plans to reline the plant's blast furnace, which

SPECIFYING A GEAR TYPE COUPLING IS NOT ENOUGH



Unretouched photo of WALDRON Heavy Duty Coupling between speed reducer and mill at Crucible Steel Co. of America, Syracuse, N. Y.

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WALDRON couplings are available in sizes up to 18" shaft diameter. We specialize in furnishing couplings for unusual applications and services. We would be pleased to send you our latest bulletin 55-1 upon request.

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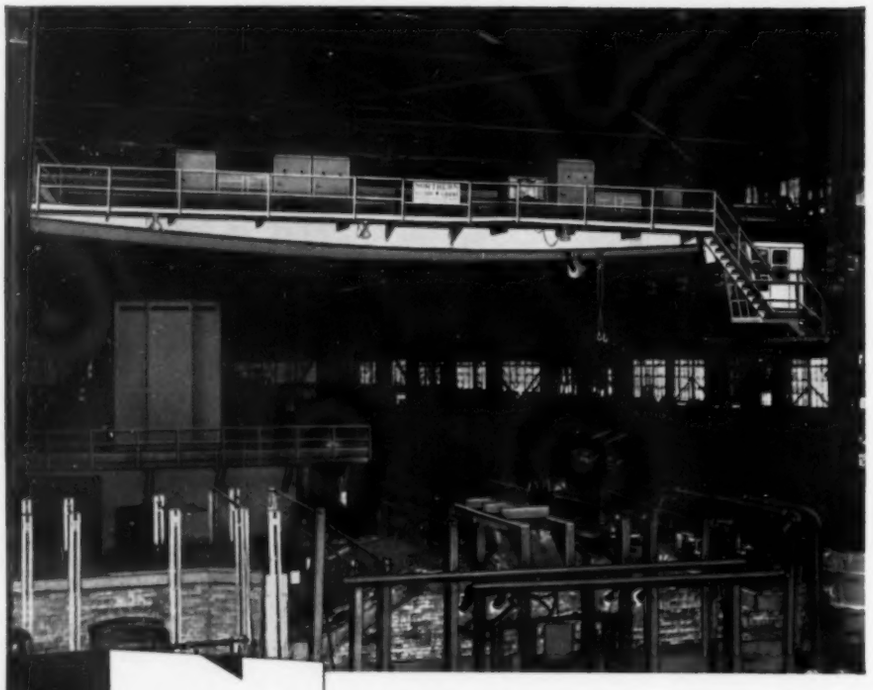

NORTHERN CRANES *for severe service! for continuous operation! for safety and economy!*

The 40-ton NORTHERN SUPER CRANE shown is one of several Northern cranes operating in the Huntington Works of the International Nickel Company.

From drawing board to assembly floor no effort is spared in building uninterrupted service into NORTHERN HEAVY DUTY SUPER CRANES. They are built to stand rough handling, overloading and continuous operation. Mechanically, structurally and electrically they offer the maximum in safety and operating efficiency.

Northern Cranes are backed by over 55 years experience in designing and building cranes for steel mills, metal fabricating plants, automobile plants, paper mills, electrical manufacturers, railroads, and many other industries.

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NORTHERN CRANES—HOISTS—TRAVELATORS

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has a daily capacity of 680 tons of iron.

The coke battery will be built on the same foundation as the present battery of ovens, which will be torn down.

The existing by-products plant will continue in service for the production of such coal chemicals from the coking process as tar, coke gas, ammonium sulphate, benzol, toluol, xylol, solvent naphtha and motor benzol.

Last coke from the present battery is expected to be pushed from the ovens approximately May 10. The new battery is expected to be in production about December 1.

Plans are for the blast furnace to be shut down sometime during the construction of the coke oven battery. It is expected to be down for relining for about two months.

Coke for the blast furnace during the period it is in operation and until the new battery is lighted will be supplied from stocks already built and from other Republic coke plants in Ohio.

Iron for the Massillon plant's nine open hearth furnaces will be supplied while the blast furnace is out of operation from a reserve supply of pig iron that has been built up and from other Republic Ohio blast furnaces.

The Koppers Co., Inc. of Pittsburgh has been awarded a contract to dismantle the present coke oven battery and erect the new one.

PROGRAM REDUCES AIR POLLUTION 75 PER CENT

▲ A five-year rebuilding program by the United States Steel Corp., American Steel and Wire Division's Coke and Coal Chemical plant has reduced smoke and fume pollution by 75 per cent. Feature of the smoke control program are two specially built larry cars just put into operation atop the coke ovens. Each car charges 12½ tons of coking coal into the glowing coke oven in four minutes. Special sleeves which fit over the charging holes and a steam-jet aspirator capture and draw off two-thirds of the fumes which escaped with the old equipment.

With this new equipment the charging holes above the ovens are open only 80 seconds until the lidman completes capping them with covers. Under the old method the holes were open during the entire four minute charging cycle.

ALLEGHENY LUDLUM USES OKOLITE-OKOPRENE feeders for 70-ton arc furnaces

Cross section of 35 KV Okolite insulated power cable (¾ actual size) which feeds arc furnaces at Allegheny Ludlum.

At the Brackenridge Plant of the Allegheny Ludlum Steel Corporation, two 70-ton and two 60-ton electric arc furnaces are equipped with Okolite-Okoprene rubber-insulated main power feeders. The cables are installed from overhead power feeders to the transformers and disconnect switches, and operate at 25,000 volts with peaks to 26,000 volts.

These single-conductor 750 MCM rubber-insulated cables with almost an inch (56/64") Okolite rubber insulation and 8/64" Okoprene sheath are rated at 35,000 volts, ungrounded. The installation at the Brackenridge Plant is another indication of the trend in industry toward the use of Okolite-Okoprene rubber-insulated cables for high voltage applications.

Okonite's new 128-page manual, Bulletin IS-1075, points out the advantages, versatility and economies obtained by the use of rubber-insulated cable for voltages up to 35,000 volts. Write for your copy to The Okonite Company, Passaic, New Jersey.

Available with either copper or aluminum conductors

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2058

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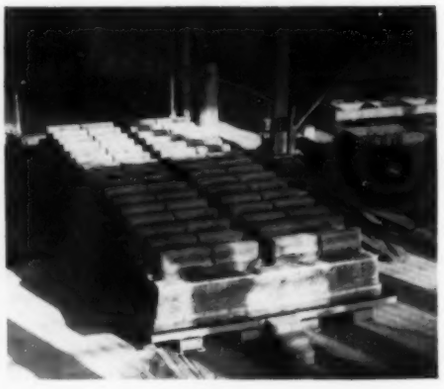

Bottoms and piers of car for large steel annealing furnaces, cast of Moldit Pier Cement, outlast fire brick about four to one.

Moldit Chrome being poured and troweled over the bottom of a large steel plate mill furnace.

Moldit Castable Refractories

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REFRACTORY CASTABLE AND BONDING CEMENTS • INSULATING BLOCK, BLANKETS AND CEMENTS

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136 WALL STREET • NEW YORK 5, N. Y.

These new charging cars plus the complete rebuilding of the 180 ovens in the four batteries eliminates 75 per cent of the smoke and fumes which boil up from the coal as it is baked in the ovens at 2500 degrees.

APPOINTS WEST COAST SALES REPRESENTATIVE

▲ Gas Machinery Co. has announced the appointment of Heat and Control, Inc., as its representative on the west coast for the firm's industrial furnace division.

IMPROVEMENT PROGRAM SET FOR BUFFALO PLANT

▲ An improvement program totaling several million dollars for the Buffalo, N. Y., plant of the Colorado Fuel and Iron Corp.'s Wickwire Spencer Division has been announced.

A program of significant additions to the plant's facilities is now under way. Under this program, Buffalo's open hearth furnaces will be made larger and more efficient, the wire mill will be increased in capacity, and new rolling machinery will go into the rod mill.

Turbo blowers are being installed in the two blast furnaces, and the open hearth furnaces are being enlarged, increasing the capacity of each from 110 to 170 tons per heat. The blooming mill will be given a general overhaul. In the billet mill, new shears will be installed and there will be a general overhaul.

DWIGHT-LLOYD DIVISION FORMED BY McDOWELL CO.

▲ Acquisition of all assets, U. S. and foreign patents, goodwill and the Dwight-Lloyd research facilities of Sintering Machinery Corp., was announced by Robert C. McDowell, president of McDowell Co., Inc.

Joining McDowell are virtually the entire executive, engineering and research staff of Sintering, including Adolph F. Leitner, executive vice-president of Sintering, who is now vice president and director of the Dwight-Lloyd Division of McDowell; and Harold E. Rowen, widely known in the sintering machine design. Mr. Rowen is general manager of the Dwight-Lloyd Division. Patrick V. Gallagher, formerly with M. H. Treadwell Engineering Co. is chief engineer.

"ENGINEERED BY DE LAVAL"

MEANS TOP PERFORMANCE IN MILL LUBRICATION...

Today, mill lubrication systems have to be complex to do the job . . . and the need for specialized experience in design becomes more and more apparent.

Which is the reason why more and more mills put their entire lubrication problem in the hands of De Laval.

De Laval's "know how" is based on years of successful experience . . . and successful installations.

With a De Laval Custom-Engineered System, owners *know* that everything has been carefully and expertly handled . . . from such major matters as pipe layout, metering of lubricant, temperature control and oil purification, down to the smallest detail.

DE LAVAL
engineered mill lubrication systems

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DE LAVAL PACIFIC CO. 61 Beale St., San Francisco 5

- **INCREASE ROLL NECK BEARING LIFE**
- **ELIMINATE REMACHINING COSTS**
- **USE LESS LUBRICANT**

with BROOKS

LEADOLENE* Klingfast

Costly roll neck wear, remachining and down time can be eliminated in blooming, slabbing, structural, wire, skelp, lapping weld, rod and pipe mills—with Brooks Leadolene Klingfast. Having a thin film of semi-hardening nature, this lubricant does not hold scale which creates abrasive conditions. Scale is continually flushed out by water which does not affect or wash off this cost reducing lubricant. Furnished in grease or oil for hand packing or for use in pressure systems.

**The I.P. Lubricant with Indestructible pH-ilm.*

Read this Case Study

FOR PROOF OF LEADOLENE KLINGFAST'S SUPERIOR QUALITY AND COST REDUCING PERFORMANCE

In a lubrication study conducted over a period of one year on a 40" blooming mill, Brooks Leadolene Klingfast proved its efficient, cost reducing qualities. Best competitive E. P. Lubricants were consumed at the rate of twenty drums per week, and bearings wore out in two weeks' time. With Leadolene Klingfast, bearings showed no wear after twelve weeks and only four drums were consumed per week.

SEND COUPON FOR COMPLETE DATA!

The Brooks Oil Company
934 Ridge Avenue
Pittsburgh 12, Pa.

☐ Please send complete information on Leadolene Klingfast for roll neck lubrication.

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It was also reported that the present Dwight-Lloyd Laboratory at Netcong, N. J., is to be expanded and moved into larger quarters in the Cleveland area. Fabrication of Dwight-Lloyd equipment is slated for the shops of McDowell's Wellman Engineering Co. division in Cleveland.

APPROVES STANDARD FOR CIRCUIT BREAKERS

▲ The American Standards Association Sectional Committees C37 and C57 approved for publication on February 2, 1955, a standard on "Preferred Ratings for Power Circuit Breakers" which was sponsored by the Electrical Standards Board after much work by members of large manufacturing companies. This publication represents standard practices in the United States relating to alternating-current power circuit breakers and contains data secured from many sources, mainly AIEE, NEMA and AEIC.

OPERATIONS BEGIN ON PHILIPPINES MILL

▲ The largest and most modern steel mill in the Philippines has started operations, at the National Shipyards and Steel Corp., Iligan City. The new steelmaking facilities, a state-owned project, mark a big step forward in the country's industrialization program.

The mill, designed and built by Loewy-Hydropress, New York, will help make the Philippines self-sufficient in their steel needs. It will make available, items such as bars, structural shapes and angles.

WILL PRODUCE LIQUID OXYGEN AT WASH. PLANT

▲ Linde Air Products Co. is installing equipment at their plant at Seattle, Wash., for the production of liquid oxygen, according to C. S. Richmond, Pacific Northwest manager, and F. J. Zeman, superintendent of the Seattle plant. Facilities originally installed in 1917 for the production of gaseous oxygen only, will be retired and the production of liquid oxygen will start by mid-summer this year.

Facilities were added in 1943 for the storage and handling of liquid

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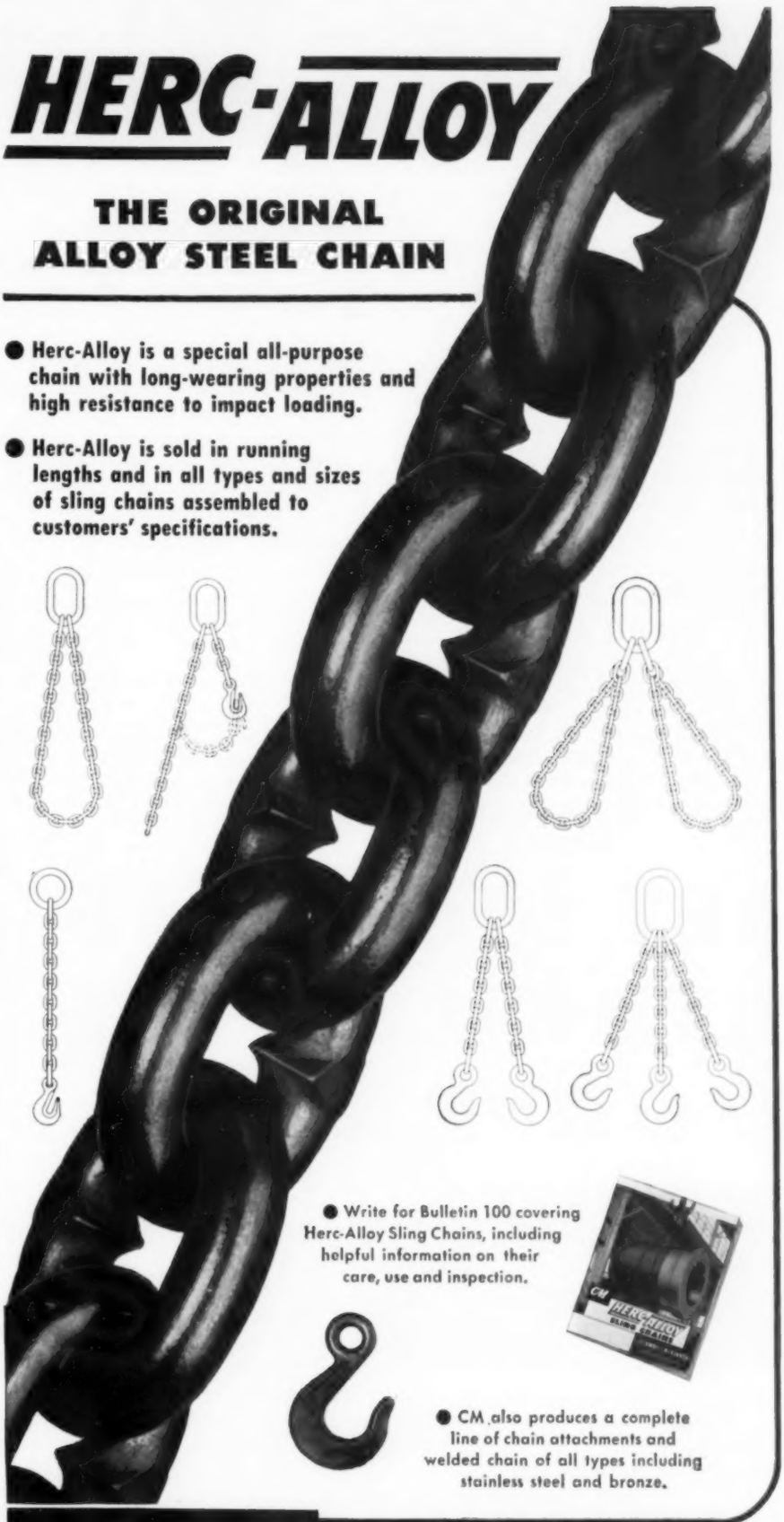

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oxygen which was received from other plants. Now, the production of liquid oxygen in Seattle will simplify distribution and assure customers in the area a more completely flexible and dependable source of oxygen.

The new plant facilities will have a liquid capacity equivalent to 10 million cu ft of gas per month and will include facilities for handling other atmospheric gases, principally argon and nitrogen. From the location in Seattle, bulk shipments of liquid can be made quickly and easily to other distributing points in the Pacific Northwest.

Linde also has liquid oxygen producing plants on the Pacific Coast at Berkeley, Los Angeles, and Fontana, Calif.

INSUL-MASTIC CORP. MOVES HOME OFFICE

▲ Insul-Mastic Corp. of America is transferring its home office from Pittsburgh, Pa., to the office building of its plant in Summit, Ill.

Company officials foresee that combining of the sales and manufacturing divisions at one central location will produce more coordination between the two and better service to the company's customers. Moving is expected to be completed by the end of April.

ANNOUNCE MERGER OF RADIATOR FIRMS

▲ Merger of the National Radiator Co., Johnstown, Pa. and United States Radiator Corp., Detroit, Mich., has resulted in the formation of National-U. S. Radiator Corp.

The merged corporation with general offices in Johnstown will have combined net sales of over 50 million dollars and combined assets of approximately $28,500,000.

W. C. McCord, president and a director of U. S. Radiator, has been named chairman of the board of the firm.

Theodore B. Focke, president of National since 1952, is president of the corporation. L. L. Hotsenpiller, vice president for National's manufacturing, is now executive assistant to the president.

Carroll M. Baumgardner, vice president for National's sales retains that position in the new corporation. Howard B. Steggall, formerly senior vice president and a U. S. Radiator director is now vice president for manufacturing in the new corporation. He is also a director.

As a result of the merger, National-U. S. Radiator Corp. will market a comprehensive line of heating equipment including cast iron heating products, steel boilers for every commercial and residential steel boiler need, packaged steam generator units sold under the name of "Cyclotherm," and related items.

The securities of the merged corporation are currently being traded on a "when issued" basis on the American Stock Exchange.

BLOOM ENGINEERING CO. NAMES REPRESENTATIVE

▲ Bloom Engineering Co., Inc. has appointed the Robert Warnock Co. of Birmingham, Ala. as its sales representative in the Birmingham area. The company will handle the complete line of Bloom combustion equipment.

Future Meetings

▲ The Annual Spring Meeting of the Metal Treating Institute will be held at the Ambassador Hotel, Los Angeles, Calif., May 9, 10, 11.

▲ The 58th Annual Meeting of the American Society for Testing Materials is scheduled for Chalfonte-Haddon Hall, Atlantic City, N. J., June 26 to July 1, 1955. A total of 30 sessions are scheduled. Six symposiums are scheduled on the following subjects: impact, judgment factors in soils testing, significance of tests of concrete, high purity water corrosion, speed of testing, and metallic materials for service above 1600 F. In addition, sessions are scheduled at which individual papers will be given on the subject of soils, non-ferrous metals, steel, testing of materials, and fatigue.

▲ The American Welding Society will hold its National Spring Meeting and the concurrent Welding Show at Kansas City, Mo., June 7 to 10.

The Spring Meeting sessions will be held at the Hotel Muehlebach and the exposition at the Kansas City Auditorium.

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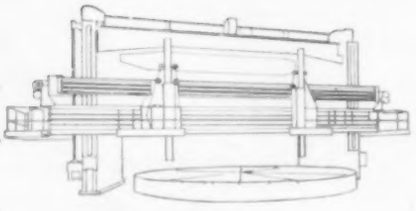

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Note: Post cards expire three months after publication date.

(1) Lubrication

"Lubrication of Steel Mill Equipment" is the title of a new booklet published by United Engineering and Foundry Co. The 28-page brochure discusses general methods of lubrication on steel mill equipment. Circulation systems, bath-splash systems, mechanical force feed systems, and hydraulic systems are a few of the general lubricating types explained in the bulletin. Schematic diagrams of these lubricating systems, and a steel plant flow diagram are included in this comprehensive outline of the lubrication needs in the daily operation of steel mill equipment.

(2) Atmosphere Chart

A special atmosphere chart is available from the Electric Furnace Co., which gives data on various percentages of CO_2; O^2; H_2; CO; CH_4: — Parts H_2O for 530, 1030, 2550 Btu gases for various percentages of perfect combustion ratios. Data for percent carbon head is also plotted against these percentages of perfect combustion ratios.

(3) Brazing

A 24-page brazing manual concerned with the application of the major brazing methods in joining metals using silver alloys and filler metals, fluxes, and gas atmospheres is available from Air Reduction Sales Co. Over 20 tables, drawings and illustrations are reproduced in the booklet. Some of the subjects discussed include silver brazing procedure selection of brazing and filler metals, design of brazed joints, prebraze cleaning, and assembly of brazed joints. (Catalog 925)

(4) Electric Furnace

Available from American Bridge Division, United States Steel Corp., is a 28-page booklet explaining the installation and operating procedure of the electric furnace. The three general types of furnaces are discussed in the bulletin: those used as melting units, those for both melting and refining, and those for refining only. Also included are furnace sizes, capacities, and transformer ratings. Photographs of the various electric furnaces illustrate the brochure.

(5) Bearing Maintenance

A 19-page illustrated manual discussing proper maintenance of rolling mill bearings has been published by the Torrington Co., Bantam Bearings Division. Outlined in the brochure are uses of bearings, and procedures for increasing bearing service and life. Comprehensive information on mountings, installation, lubricating and fitting practices is given. Also included is a practical check list showing 19 common causes of bearing failure and recommended preventives. Drawings, charts, tables and photographs illustrate the booklet.

(6) Power Connectors

Delta-Star Electric Division, H. K. Porter Co., Inc., has published a new catalog describing power connectors for use with copper and aluminum conductors. The catalog, compiled in ten sections, includes an extensive data section containing tables, charts and technical articles. Other sections discuss tubing to tubing connectors, cable to cable, tubing to cable, tube or cable to bar, square tubing, flexible connectors, grounding and stud connectors, and terminal lugs. (Bulletin 38-E)

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52	ASKANIA REGULATOR CO.	BULLETIN 161 AND 139	Straight coils.
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55	E. W. BLISS CO.	CATALOG 40-A	Rolling mills.
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58	BUFFALO FORGE CO.	BULLETIN 2424-E	Rubber-lined exhausters.
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60	CLARK CONTROLLER CO.	BULLETIN 6080	Reduced voltage starters.
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62	CRANE CO.		Valves.
63	DE LAVAL STEAM TURBINE CO.	BULLETIN 0504	Centrifugal compressors.
64	DELTA-STAR ELECTRIC DIVISION, H. K. PORTER CO., INC.	BULLETIN 38-E	Power connectors.
65	DIAMOND POWER SPECIALTY CORP.		Industrial television.
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69	ELECTRIC CONTROLLER & MANUFACTURING CO.	BOOKLET 9250	Automatic-positioning screwdown control.
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71	ELECTRIC STORAGE BATTERY CO.	FORM 1982	Motive power batteries.
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80	KOPPERS CO., INC.		Electrostatic precipitators.
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93	REFRACTORY & INSULATION CORP.		Castable refractories.
94	ROCKBESTOS PRODUCTS CORP.	SPEC. RSS-88	Test and construction specifications of Rockbestos.
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97	STEARNS MAGNETIC, INC.	BULLETIN 35-C	Lifting magnets.
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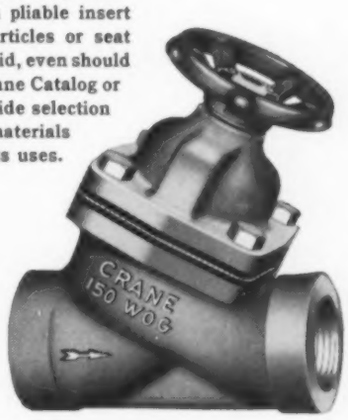
The trouble was in the plug cocks and conventional gate valves formerly used in the enamel lines. During normal shutdowns the heavy liquid would build up on seating surfaces, in stem threads and working parts. The cocks and gates would "freeze up" . . . were hard to operate . . . couldn't be shut tight. The condition hampered production . . . made floors messy and dangerous . . . pushed maintenance costs sky-high.

Replacing with Crane Packless Diaphragm Valves stopped the trouble completely. Their sealed-to-fluid bonnet and pliable neoprene disc insert did the trick. After more than 4 years, all 48 Crane valves installed—with no maintenance whatsoever—are still seating tight . . . still operating freely and smoothly.

CRANE PACKLESS DIAPHRAGM VALVES

Working parts are safely out of contact with line fluid. The diaphragm seals the bonnet—that's all it does, giving it longer life. The independent disc with pliable insert seats tightly on foreign particles or seat deposits . . . and controls fluid, even should diaphragm fail. See your Crane Catalog or Crane Representative for wide selection of body, bonnet, and trim materials in these valves for countless uses.



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Personnel News...

John G. Garland was promoted to assistant division superintendent, maintenance at the Duquesne Works, United States Steel Corp. Mr. Garland joined U. S. Steel in 1923 at the Homestead Works, and was successively general foreman — blast furnace maintenance; general foreman — electric shop and motor rooms; and superintendent — structural mill maintenance. In 1951 he was appointed superintendent, assigned and operating maintenance at Duquesne Works, the position he held at the time of his present promotion.

Ivan R. Rebert was appointed superintendent of the plant production planning department at Kaiser Steel Corp., Fontana, Calif. He succeeds **John W. Miller** who was transferred to the Oakland, Calif., home office to manage product planning for the corporation. Mr. Rebert has been with Kaiser since 1944, coming from Great Lakes Steel where he worked from 1933 to 1944 in various supervisory positions in ordering and scheduling. He came to Kaiser as mill provider for the structural mill, was appointed production supervisor in 1945 and then assistant superintendent of production planning in 1948.

W. F. Munnikhuysen was elected chairman of the board and **Fred C. Foy** was named president and chief executive officer of Koppers Co., Inc. Election of Mr. Munnikhuysen and Mr. Foy fills the vacancies created by the death last February 13 of **General Brehon Somervell,** who had been both chairman and president. Mr. Munnikhuysen has been executive vice president of Koppers since 1950. Previously he had been vice president and general manager of the company's wood preserving division. He first joined the company in 1916. Mr. Foy, who joined Koppers in 1948, has been vice president and general manager of the company's tar products division since 1950, and a member of the company's board of directors since last May. For the past six months he has been on special assignment to the president's office while retaining his duties in the tar products division. He was also elected a member of the executive committee of the board of directors. **R. R. Holmes** was elected vice president and general manager of the tar products division, succeeding Mr. Foy. Mr. Holmes, who joined Koppers in 1923 has been a divisional vice president and assistant general manager of the division.

Daniel H. Dellinger was appointed assistant vice president in charge of research, development and quality control for the Great Lakes Steel Corp. Mr. Dellinger began his association with National Steel in June 1931 as a metallurgist with the Weirton Steel Co. In 1936 he went into the technical service for tin plate and in 1948 he became manager of the technical service and inspection department. In 1954, he became assistant to the vice president — quality control, of National Steel Corp., the position he held at the time of his current appointment.

Harold C. Seifert has been appointed manager of Republic Steel Corp.'s bolt and nut division, succeeding **John Dunlop** who has been transferred to the industrial engineering department in the company's general office. **Charles A. Paler,** superintendent of the steel company's Gadsden, Ala., bolt and nut plant, will move to Cleveland to succeed Mr. Seifert as assistant manager of the division. **J. C. Noble** will succeed Mr. Paler as head of the Gadsden plant. Born in England, Mr. Seifert came to the United States in 1924 and began working for Corrigan-McKinney Steel Co. Subsequently, he joined the Upson Nut Co. which became a part of Republic when the steel company was formed in 1930. In turn, he held positions of machine shop foreman, night superintendent and superintendent of the cold bolt departments before his appointment as assistant works manager in September, 1954.

C. H. Kibler has been promoted to general traffic manager and **Neil Robertson** to assistant general traffic manager of the boiler division of the Babcock & Wilcox Co.

Robert Graham was appointed assistant superintendent of the cold strip department at the Midland Works of Crucible Steel Co. of America. Mr. Graham joined Crucible in 1937. He has held various supervisory positions in the mechanical maintenance department and the cold strip department prior to his present promotion.

JOHN G. GARLAND

IVAN R. REBERT

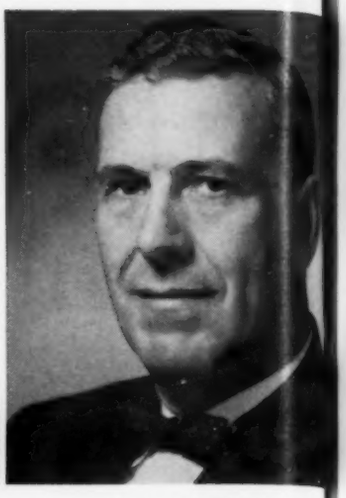
W. F. MUNNIKHUYSEN

FRED C. FOY

GEORGE W. KROSS, JR.

CARL J. STOOPS

ALBERT W. GUDAL



S. A. HUFFMAN

George W Kross, Jr. was promoted to superintendent of the tubular products division plant of the Babcock & Wilcox Co. in Alliance, Ohio. At the same time it was revealed that **Carl J. Stoops** has been named assistant superintendent.

Albert W. Gudal has been appointed to the position of assistant purchasing agent of Lukens Steel Co. He also becomes a member of the company's management council. Since 1952 he has been supervisor of planning and controls. Mr. Gudal received his early business experience with Armco Steel Corp. and Armco International Corp.

S. A. Huffman was appointed superintendent of mechanical maintenance of Reserve Mining Co. He was formerly superintendent of the mechanical departments of a steel plant on the West Coast for eight years. Before that, Mr. Huffman served as assistant superintendent of mechanical maintenance for 12 years at a Pennsylvania steel plant.

Victor F. Koerner was elected to the position of assistant secretary of Mesta Machine Co.

Albin M. Degner, works manager of Surface Combustion Corp., has retired from active duty after 45 years of service. He was first employed in 1910 at Improved Appliance which later merged with Surface Combustion. He became works manager for Toledo and Columbus when Surface purchased the gas heating division of Columbus Heating and Ventilating in 1930.

Milan P. Getting, Jr., since 1947 assistant to the works manager at Allis-Chalmers Pittsburgh Works, has been appointed assistant to general manager **D. A. Griffith.** His successor is **George Shombert, Jr.,** assistant superintendent of the electrical test department since 1949. Mr. Shombert, in turn, is succeeded by **Sebastian W. Phillippi.**

Roy A. Salter has been appointed first vice president of the Southern Wheel Division of American Brake Shoe Co. Formerly vice president of the division, Mr. Salter has been with the company since 1924. He was appointed vice president in charge of operation in 1936. He will continue to be located at division headquarters in New York.

Hugh F. Lacey has been appointed traffic manager for Joseph T. Ryerson & Son, Inc. Formerly assistant traffic manager, he succeeds **Carl Kuhn** who has retired after 44 years with the firm.

Leslie L. Andrus, vice president of the American Wheelabrator & Equipment Corp. and executive head of its dust and fume control division, has been elected

LESLIE L. ANDRUS

to the board of directors. **Harold M. Miller,** vice president of the corporation since 1944, and a member of the firm since 1923, was also elected a director.

D. W. McGill has been appointed manager of the steel mill and metalworking section of the Westinghouse Electric Corp.'s industrial department. He will be responsible for sales within the ferrous and non-ferrous metal producing, metal working and automotive industries. He will be located at the company's East Pittsburgh, Pa., plant.

John W. Miller has been appointed manager of product planning for Kaiser Steel Corp. He joined Kaiser Steel in 1944 as assistant superintendent of

Left — Heavy, felted asbestos walls are applied over and under the varnished cambric tapes . . . then thoroughly impregnated . . . *Right* — then the impregnated asbestos is compressed to a dense, homogeneous wall that ensures long cable life.

look beneath the braid

. . . that's where quality begins

felted asbestos walls assure long cable life

N.E.C. Type AVA cables may look alike, but a look under the braid shows how time-proven *Rockbestos A.V.C.* Type AVA is built to ensure long life.

Each asbestos wall in *Rockbestos A.V.C.* construction is a dense, homogeneous, "seamless tube" . . . long, silky fibres of asbestos, thoroughly impregnated with selected compounds, make a nonporous, permanently heat-resistant wall. Heat dissipation is uniform. Dielectric strength is maintained under severe conditions. This seamless construction cushions the cable, protects the varnished cambric from rupture in the sharpest bends.

Write for the test and construction specifications of *Rockbestos A.V.C.* available in the new booklet: "Specification RSS-88".

STOCKED COAST TO COAST
Standard Rockbestos A.V.C. construction (N.E.C. types AVA, AVB, etc.) are available for immediate shipment. Call or write nearest branch office.

ROCKBESTOS PRODUCTS CORP.
NEW HAVEN 4, CONNECTICUT

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production planning, at the company's Fontana, Calif., plant. Since then he has held posts as assistant to the general superintendent, Fontana operations, and most recently as superintendent, production planning. Mr. Miller spent six years with the Baltimore & Ohio Railroad, and twelve years with the United States Steel Corp. in various managerial posts before joining Kaiser Steel.

Curtner B. Akin has been named assistant works manager of the Ambridge, Pa., plant of National Electric Products Corp. Mr. Akin joined the company in 1950 as a development engineer, specializing in mechanical tubing and electrical fittings. He assisted in the development of new galvanizing processes for the com-

CURTNER B. AKIN

pany's rigid steel conduits and electrical metallic tubing. He was for some years associated with the former United Tube Corp. He later served as superintendent of the Adrian, Mich. tube mill of Brown Fence & Wire Co. Mr. Akin came to National Electric from the Service Steel Co. where for five years he sold steel tubing throughout the Detroit area.

John P. Kinville was named vice president of the Michigan Limestone Division of United States Steel Corp.

Ralph Winslow, vice president of Koppers Co., Inc., will head the firm's newly-created marketing department. The new department will include sales management, market and economic research, sales personnel development, sales promotion, advertising and public relations sections. **Cooke Bausman, Jr.,** former manager, sales department, was named assistant to the general manager of the company's chemical division. **George W. Naylor,** who has been assistant sales manager of the tar products division, also is being transferred to the chemical division as manager, international department. Succeeding him in the tar products division post will be **Harry P. Neher,** who has been assistant manager of the central staff sales department.

Paul D. Metzger has been appointed associate chemical engineer — lubrication and fuels at Wheeling Steel Corp.'s research laboratory at Benwood, W. Va.

Dr. Benjamin S. Mesick has joined the staff of Arthur D. Little, Inc. Dr. Mesick retired from the Army in 1954, after 30 years of service. He was formerly commanding officer of the Watertown, Mass., Arsenal. As a senior staff member at Arthur D. Little, Inc., his chief responsibility will be to expand the company's activities in the titanium fabrication field, and to explore the numerous industrial uses for this strategic metal.

Dwight C. Brown has been appointed senior process engineer in the research and development department of Jones & Laughlin Steel Corp. Mr. Brown, formerly associated with the research organization of the Stauffer Chemical Co., has been assigned to work in the fields of coal chemical operations, industrial waste problems, and process developments involving lean ore.

Glenn M. Herring has been appointed manager of steel mill sales for Hanson-Van Winkle-Munning Co. At the same time **William H. Brown** was named sales representative for eastern Pa., and **Frank W. Mountain** for western Pa., W. Va. and Ala.

Walter Winiarczyk has been appointed assistant superintendent of the mechanical department at Colorado Fuel and Iron Corp.'s Buffalo Works. Mr. Winiarczyk started working at Buffalo in 1947 as an engineer. In 1953 he became mechanical coordinator of plant engineering.

Edward H. D. Gibbs has been appointed vice president in charge of sales of Heyl & Patterson, Inc. Mr. Gibbs joined the company in 1948 as a contracting

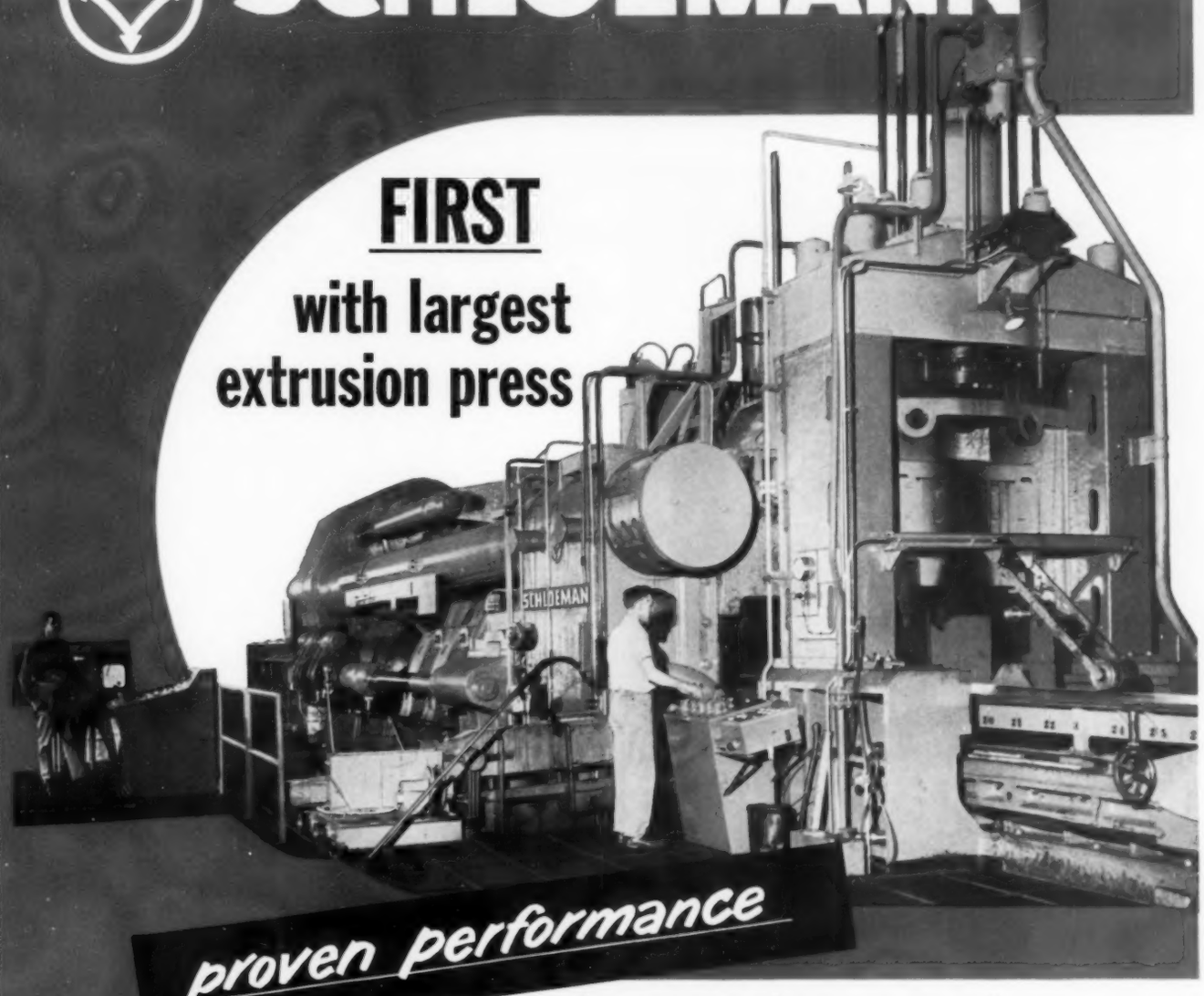
EDWARD H. D. GIBBS

engineer, serving in that capacity until he became sales manager in 1954. Prior to joining Heyl & Patterson, he had worked since 1937 for United States Steel Corp. in various engineering capacities.

A. E. Tarr, formerly manager of Leeds & Northrup Co. sales engineering division, was appointed assistant to the president. He is succeeded by **Harold L. Scutt,** formerly sales manager of the New York district, who moves his activities to Philadelphia. **Nathan Cohn,**

SCHLOEMANN

FIRST
with largest extrusion press



proven performance
for more than a year!

This 14,000 ton extrusion press (illustrated above) has been in successful operation for more than a year. As a key unit of the U. S. Air Force Heavy Press Program, this Schloemann press produces light metal shapes up to 110 feet in length and up to 2500 pounds in weight. Substantial economies are made possible with this unit as well as greater flexibility of design.

You are invited to contact our engineers for a discussion of your extrusion press requirements for any industrial production.

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by
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Domestic users of equipment built by Schloemann are assured of competent service-engineering, supply of genuine spare, and repair parts. Call a Feller service engineer.

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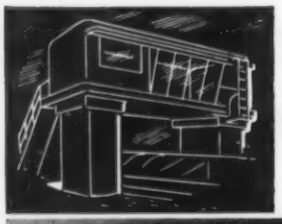
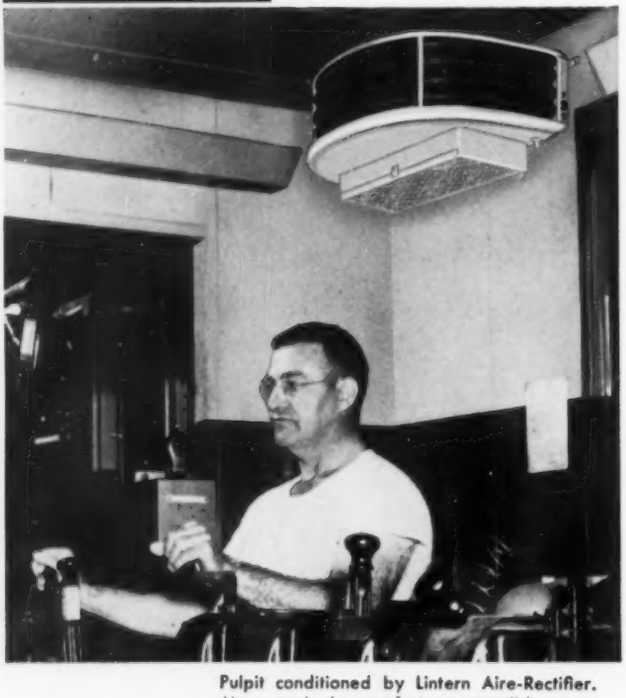
PULPIT CONDITIONERS



for every need by LINTERN



Pulpit conditioned by Lintern Aire-Rectifier. Men work in comfort, accomplish more. Better personnel relations. Production scores.

Cool, clean air throughout the pulpit . . . no drafts . . . no unsightly, expensive ducts. This is what you get with the Lintern Pulpit Aire-Rectifier.

Condensers, located adjacent to the pulpit, are connected to cooling coils inside by small, easily concealed refrigerant lines. Your choice of water cooled or air cooled condensers.

Two choices also of cooling units (1) ceiling mounted (for crowded pulpits) or (2) floor mounted where you have the room.

Included in each model are electric heaters which keep pulpits comfortable no matter how cold the weather.

Production "push-uppers"— these conditioners. Ask for new Bulletin P-552.

THE LINTERN CORPORATION

ROUTE 20, EAST
PAINESVILLE, OHIO

formerly manager of the west central sales region with headquarters in Chicago, also moves to Philadelphia to be manager of the market development division. He replaces **L. E. Emerich,** who recently was named director of marketing. **H. Raymond Abey,** who has been manager of the eastern sales region, was appointed manager of the marketing services division, succeeding the late **A. Merrill Redding. J. William Robinson,** formerly manager of the western sales region becomes western sales manager. He will continue to make his headquarters at the firm's San Francisco office.

Jack R. Hight has been named manager of public relations of Allegheny Ludlum Steel Corp.

J. B. Sewell was elected a vice president of the Garlock Packing Co. Mr. Sewell started with the Garlock Packing Co. of Canada, Ltd., in 1935 as a sales representative in the Montreal area. In 1947 he was elected

J. B. SEWELL

vice president of that company with headquarters in Montreal. On October 1, 1954 Mr. Sewell was appointed general sales manager of the parent company with overall direction of sales both in Canada and the United States. As vice president he will continue directing sales operations of the company.

H. L. Peek was promoted to engineer-in-charge of the development group at Allis-Chalmers Manufacturing Co.'s Boston Works. In addition, **W. L. Vance** was named to engineer-in-charge of circuit breaker design, and **J. F. Claffie** to section engineer for high voltage outdoor breakers.

Theodore Kauffman, Jr. was elected president of the S. Obermayer Co. He succeeds **Theodore Kauffman,** who becomes chairman of the board. Mr. Kauffman, who was vice president in charge of the company's Ramtite Division is succeeded by **George V. Campbell. Frank B. Flynn,** in charge of the Obermayer Division was elected executive vice president of the corporation.

Franklin Farrel, 3rd, was elected president of Farrel-Birmingham Co., Inc. He succeeds **Franklin R.**

Hoadley, who has served as president since 1945 and who will retire May 1, 1955. **Alton Austin Cheney** was re-elected chairman of the board, and **Austin Kuhns** chairman of the finance committee.

Obituaries

Béauford H. Reeves, 63, president of Rockbestos Products Corp., died April 1. His death followed by twenty-nine days the sudden death of the company's

BEAUFORD H. REEVES

first and only other president, **Arthur Grove Newton.** Mr. Reeves had been elected president of the wire and cable company on March 5 at a special meeting of the board of directors. He had served as vice president and general manager since 1936.

Elton Hoyt, 2nd, senior managing partner, Pickands Mather & Co., died March 16. He was 66. Mr. Hoyt had been identified with his firm for 44 years.

Harry B. Lilley, a 30 year employee of the Timken Roller Bearing Co. and district manager of the steel sales division in that company's Detroit, Mich., office, died March 24.

George W. Yanney, former chief engineer of Alliance Machine Co., died March 11. Mr. Yanney has been active in the crane industry for many years and also in the affairs of the AISE.

Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

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FAST···LEGIBLE BILLET MARKING!

now made possible with the *NEW*

Pneumatic BILLET MARKER

This new, compact unit stamps ends of billets 4" x 4" or larger with a deep, legible mark as shown above. Unit is mounted on an I-beam track and powered by heavy duty air cylinder. Quick change type holder is kept in stamping position at all times without special guides.

WRITE for complete data.

Mecco SAFETY MARKING TOOLS **M.E.CUNNINGHAM CO.**

1041 CHATEAU STREET, PITTSBURGH 33, PA.

there is a top quality

LEWIS ROLL

for every rolling mill operation

Every step in the manufacture of Lewis Rolls, from raw materials through melting and pouring to machining and grinding, is performed with but one objective:

To deliver top quality, matched rolls designed specifically for each rolling mill operation.

That is why Lewis Rolls are put into operation with a minimum of grinding to provide greater tonnages of quality products in continuous production.

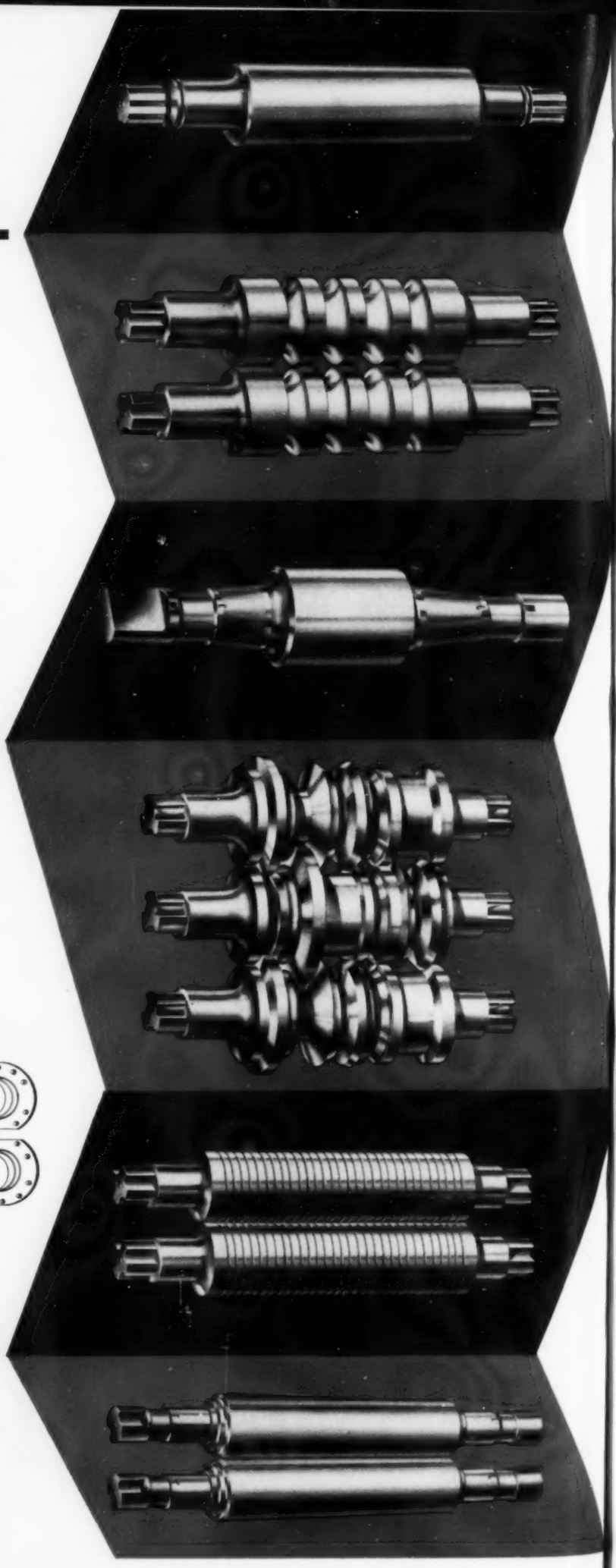
Lewis Rolls are strong, tough and long-lasting.

So be sure to always specify and use quality Lewis Rolls in your operations, whether for roughing, intermediate or finishing stands . . . for rolling any metal. They cost you less in the long run.

99 YEARS OF ROLL MAKING:

Superior "X" Rolls • Ajax Duplex Rolls • Lewis "X" and "XA" Rolls • Special Process Rolls • Climax and Ajax Rolls • Plain Chilled Rolls • Special Tube Mill Rolls • Atlas, Atlas "B" and Atlas "X" Rolls • Molybdenum Chilled Iron Rolls

Matched Rolls Mean Greater Tonnage



BLAW-KNOX

LEWIS ROLLS

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Lewis Rolls Department • Pittsburgh 1, Pa.

Rolls for Slab Mills, Bloom Mills, Billet Mills, Bar and Rod Mills, Merchant Mills, Plate Mills, Hot and Cold Strip Mills, Tube Mills

Equipment News...

RECORDERS

▲ Introduced by General Electric Co., is a new line of general purpose, strip-chart recorders featuring a plastic throw-away inkwell.

The devices measure and record current, voltage, power, frequency or speed to help achieve lower operating costs, increased efficiency and improved quality control. The recorders, available in three models, portable, semiflush, or surface mounted, chart a continuous record of an electrical quantity against time.

Replacement ink for the recorder is supplied in plastic inkwells containing three ounces, triple the amount normally contained in the usual open type well. The containers are delivered sealed for quick insertion with no spilling. All the ink is used before disposal of the container since the minute pen opening has been designed to cut evaporation to a negligible quantity.

The record rolls are 150 ft long to permit less frequent changing and they utilize light green lines for sharp contrast with the standard red ink. Twenty-eight different chart speeds are available, ranging from ¼ in. per hr to two in. per sec, and response time is fast. As little as half a second is required for the durable metal alloy pen to respond to circuit changes.

The recorder case is weather resistant with rubber gasket-sealed door and is constructed of die-cast aluminum. The portable model's dimensions are: $10\frac{15}{32}$ in. wide; $17\frac{5}{32}$ in. high; 13 in. deep. The surface and semiflush mounted models vary slightly from the portable.

HOLDER UNIT

▲ Development of Model RSCL curved line holder is announced by M. E. Cunningham Co. This holder simplifies stamping on ends of round bars, shafts and tubular sections.

The unit can be supplied with or without a gage which enables the operator to position the holder quickly so that all parts will be marked in an identical position. In stamping solid bars or shafts, almost any size can be marked with the same holder. For tubular parts the radius of the type circle can be arranged to suit several sizes within a limited range.

A special feature is the snap slide type retaining device. When the slide is opened, the retaining bar drops out of slots in the type, allowing it to be changed quickly and easily. When the slide is closed a wedge arrangement lifts the retaining bar up into type slots, securely locking type in holder.

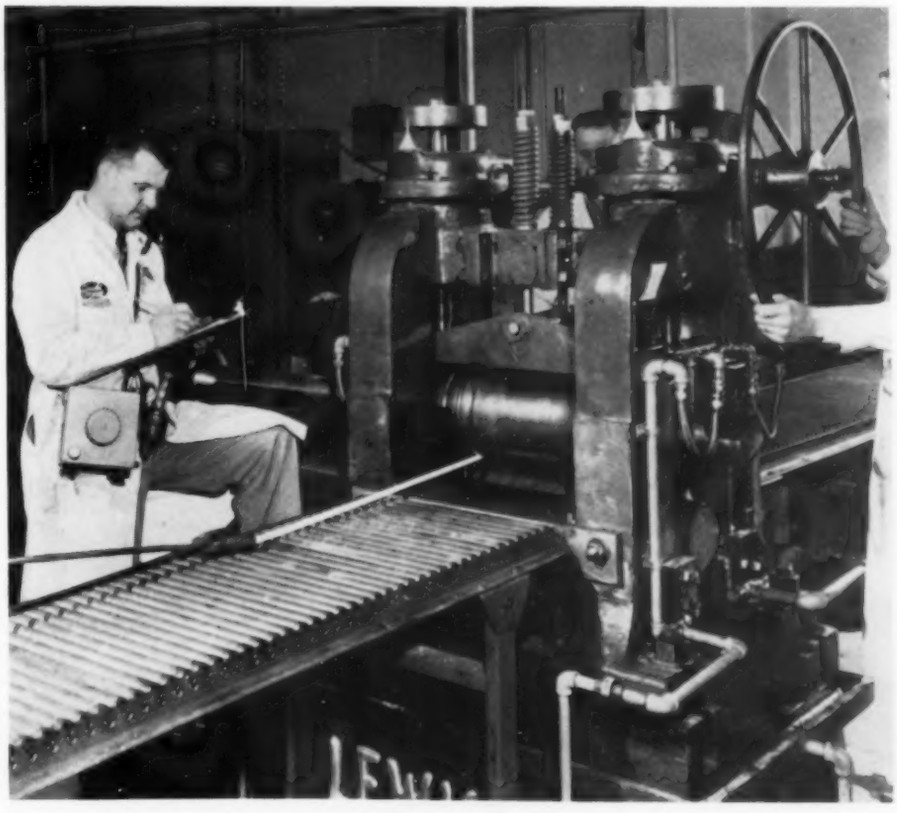
Made from special non-spalling and non-mushrooming steel, the curved line holder can be produced in almost any size or capacity of type.

COOLANT

▲ Announced by S. C. Johnson & Son, Inc., is a coolant that eliminates foul odors. Known as TL-131, the water soluble coolant is guaranteed for two full months not to turn sour and smell. The coolant does not require the use of irritating formaldehyde or bactericides before it is placed in a machine. It is used the same way as any conventional water soluble coolant. The only condition

LABORATORY MILL ROLLS HOT OR COLD ALLOYS

Designed by Lewis Machinery Division of Blaw-Knox Co., this 8½ x 10 lab mill is powered by 50 hp main motor and will operate at up to 150 fpm. It will roll either hot or cold alloys with an initial thickness of up to 2½-in. with a maximum rolling load of 200,000 lb. The unit is installed at Ford Motor Co.'s scientific laboratory and has been used to roll both sheet and bar stock of pure iron as well as high temperature alloys.



Amazing new Taylor Made

ALLOY STEEL

TAYCO HOOKS

- Extra area above eye assures longer life!
- Large eye reduces joiner link wear!
- I-Beam type design assures greater strength—provides grip for hooker!
- Drop Forged from heat-treated alloy steel!
- Wider, deeper throat!
- Resists twisting to greater extent than conventional sling hooks!

Pat. No. 2,646,306

TAYCO SLING HOOK

TAYCO GRAB HOOK

Stronger–safer–lasts longer than conventional hooks!

Patented I-Beam type *design*... Taylor's *special analysis alloy steel*... plus complete heat-treatment are reasons for the greater strength and longer life of Tayco Hooks. A larger eye, greater area above the eye and a bigger neck are additional factors. More resistant to shock, grain-growth, work-hardness and side bending than regular hooks. Will not open even under *dangerous point* loading until the working load limit of the chain (for which it is designed) is exceeded! I-Beam design provides a safe gripping area—permits handling more tonnage with less fatigue! Cut replacement and repair costs with Tayco Hooks!

S. G. TAYLOR CHAIN COMPANY
General Offices and Plant, Hammond, Ind.
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Send coupon today for free folder!

TAYLOR MADE
A GREAT NAME IN
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S. G. Taylor Chain Co.
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Hammond, Indiana
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is that the machine be cleaned and then completely recharged with TL-131.

WELDING ELECTRODE

▲ Announced by the Marquette Manufacturing Co., is a new welding electrode with a special powdered iron coating. Known as Nicol-Rod No. 99, it alloys pure nickel with iron to produce dense, high strength, machinable welds in gray, malleable and ductile cast irons.

Its outstanding advantage is the ease with which welds can be made. The arc is self-starting and the rod re-ignites without freezing to the work. A softer, more stable arc is obtained with a-c or d-c, straight or reverse polarity. Of particular importance is that the arc is more stable on low, open circuit voltages.

Extensive field tests show that sound, machinable welds can be produced in all cast irons, even those that are old, grease-soaked or corroded. Of primary interest is that the welds produced have a minimum coefficient of expansion and contraction which ends cracking during cooling. The weld metal forms a positive bond and is softer, but of greater strength than the cast iron. When finished, the weld metal matches the color of the cast iron.

When an arc is struck, the electrode develops a deep cone, causing metal to be applied to the work with more direct force. A special form of hi-bond penetration with flat bead contour is obtained by this method. More footage of weld can be made per electrode, with less spatter, less slag and with more weld deposit.

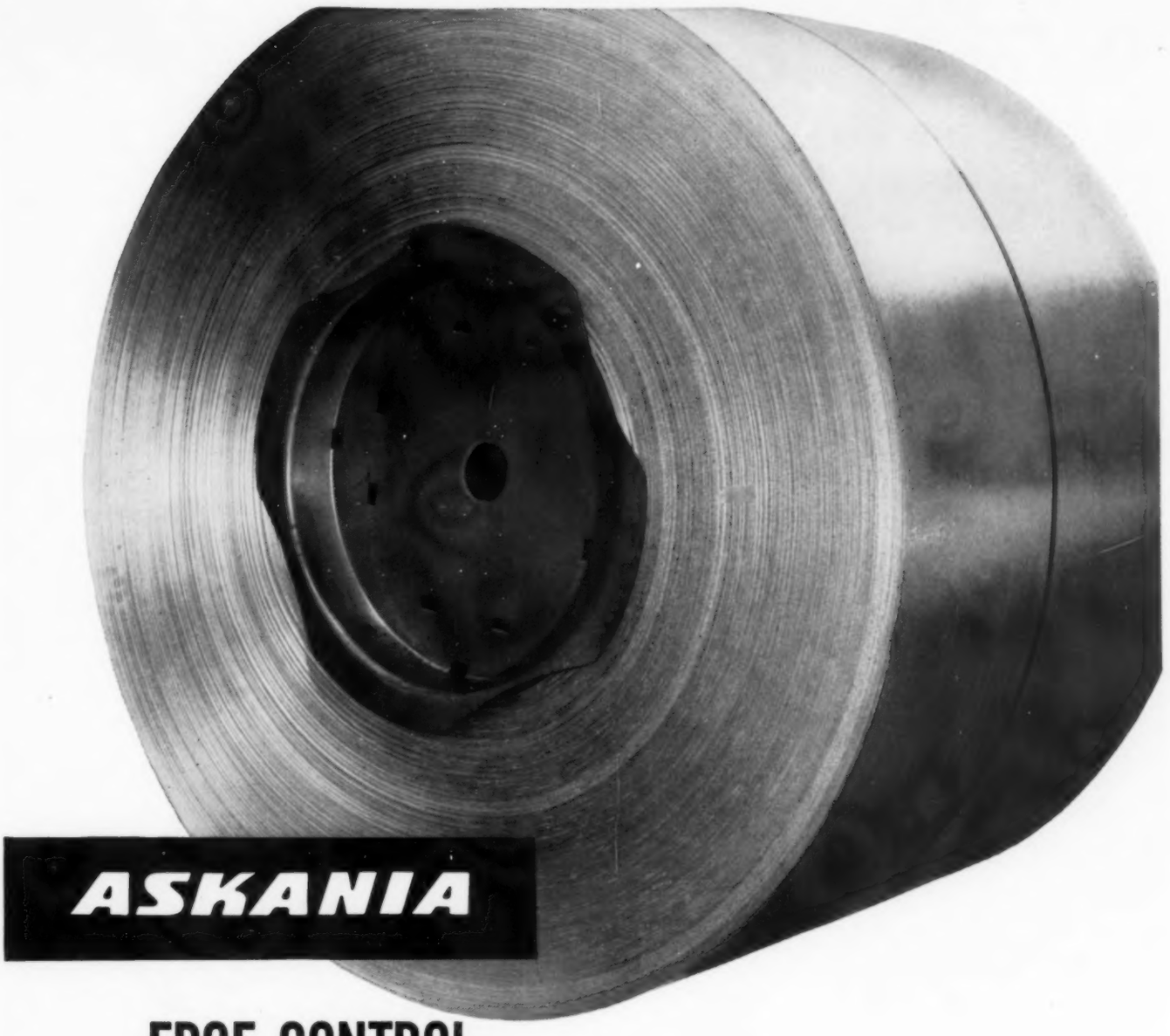
COATING

▲ West Chester Chemical Co., has developed a new protective coating for thermal insulation.

Known as "Lagz," the coating is compounded from Neoprene and silicone rubbers and other resins to provide a coating that is unaffected by moisture, oils, brine, solvents, corrosive gases, chemicals, and weathering.

The protective coating provides a moisture resistant cover which protects insulation from damage by abrasion or puncture and insures high thermal efficiency and low maintenance costs.

The coating is manufactured in two grades. No. 1 is a medium viscosity



EDGE CONTROL

positions 65,000 lb. wind-up reel to deliver straight coils

This straight coil and others just like it are produced without exception on the continuous galvanizing line at the Wheeling Steel Plant in Martins Ferry, Ohio. Even though the coil and reel together weigh 65,000 lbs., the Askania Edge Position Control reacts with sufficient speed, precision and thrust to maintain the edge position within a tolerance of plus or minus .0156 of an inch.

Simple, dependable, powerful and accurate, the Askania control is the solution to the problem that previously defied control. Any mechanic can maintain it; it is self-lubricated; it incorporates only one moving part. It delivers power instantly in almost unlimited amounts for heavy loads. It is low in cost and built to take all the abuse that continuous operation in hard service can give.

In addition, Askania maintains a special abilities department, a reservoir of engineering experience, to cope with unique problems in servo or process control, or automation.

For full details, write for Bulletin 161 and 139.

ASKANIA REGULATOR COMPANY

246 E. Ontario Street, Chicago, Illinois

Subsidiary of General Precision Equipment Corp.

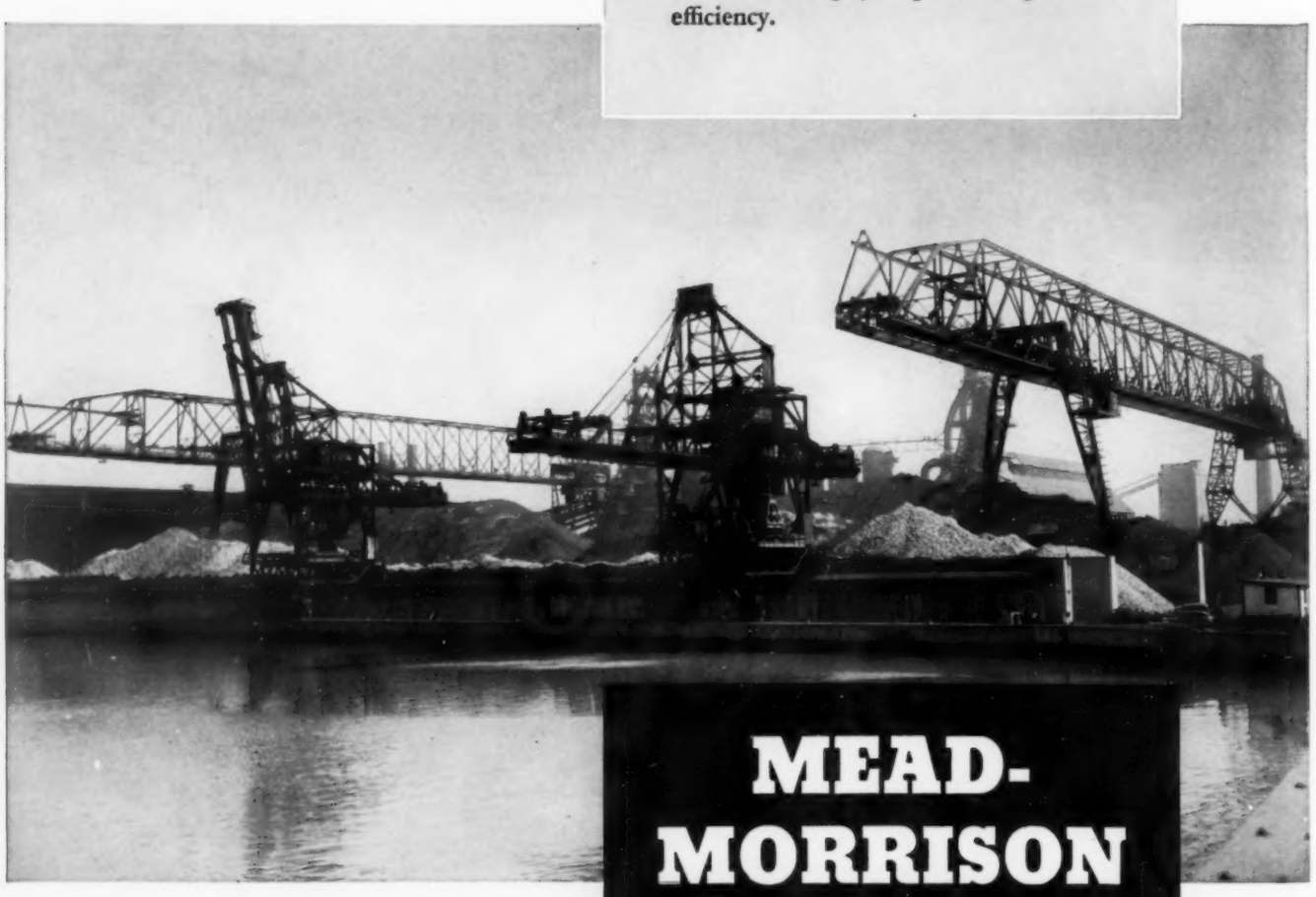
all set for speedy material handling

This team of two Unloaders and two Bridges are part of the Mead-Morrison material-handling equipment at a large midwestern steel mill.

Each of the structures and their equipment has a capacity of 12 tons and is of the man-trolley type. The unloaders discharge ore or limestone from lake steamers, and deposit it in the trough, from which it is rehandled by the bridges to storage piles and to the high line feeding the blast furnaces.

Additional Mead-Morrison Bridges and Unloaders are also operating in the coal storage yard of this same steel company.

If you need new unloading facilities or increased capacity from your present equipment, the Mead-Morrison engineers will help you plan for greatest efficiency.



MEAD-MORRISON

DIVISION OF McKIERNAN-TERRY CORPORATION · MANUFACTURING ENGINEERS · HARRISON, N. J.

MK803

material designed for use with 85 per cent magnesia, calcium silicate, felt, rock wool, and asbestos. It can be applied by spraying, brushing, or sponge. No. 2 is a high viscosity material designed for use with fiber and cellular glass. It is applied by brush or trowel and is a perfect vapor barrier.

Non-flammable and non-toxic, the coating is an excellent adhesive. It can be used to fasten insulation to surfaces and to cement the edges of formed insulation together without the use of wire ties or bands.

PULLEY

▲ Available from Lovejoy Flexible Coupling Co. is a new variable speed pulley that provides ratios up to 3 to 1 at from 7½ to 15 hp. It changes speed at finger-tip pressure while machinery is in motion. This labor and time saving feature is especially valuable where quick changes to compensate for operator ability, corrections for size or density of parts or stock, or adjustments for temperature or humidity are required.

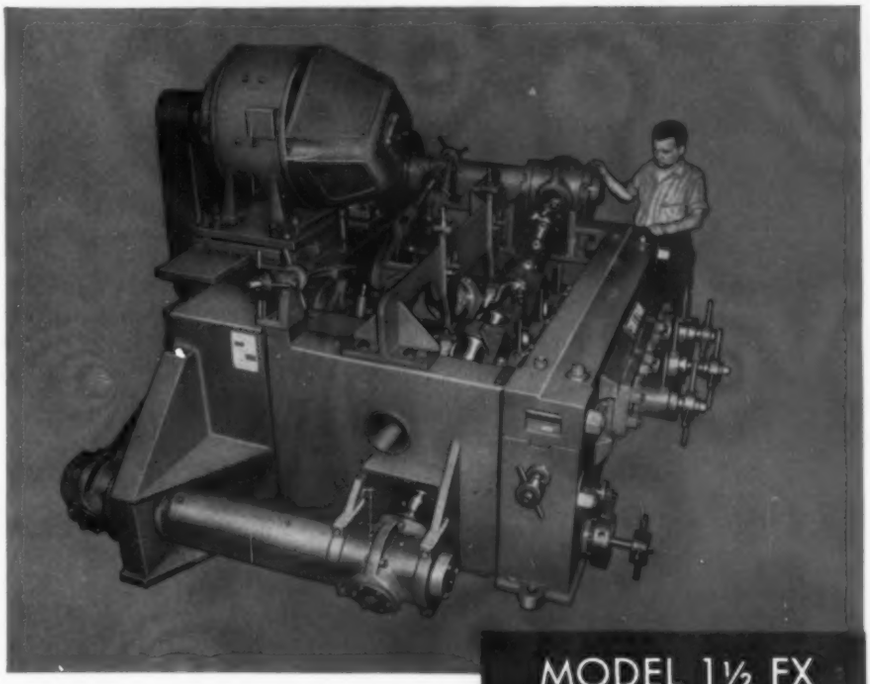
Used in conjunction with 1750 rpm motor, maximum hp is 10 with the 310 VSP base and 15 with the 315 VSP base. 1150 rpm motor affords 7½ hp with the 310 and 10 hp with the 315. Standard bores are 1¼ in., 1⅜ in., 1⅝ in. Other specifications include 13.1 max. and 4.35 min. pitch diameter, length of bore 3¾ in. and max. bore 1⅝ in.

TRANSMITTER

▲ Electrical measurements of such process variables as temperature, speed, power and pH are converted into a proportional 3-15 psi pneumatic output and transmitted to graphic panel receivers by the new EMF/pneumatic transmitter manufactured by the Foxboro Co.

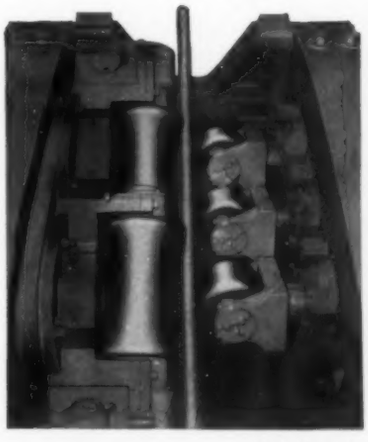
Easily mounted on the back of a control panel, the transmitter receives a millivolt signal from the measuring element (thermocouple, tachometers, etc.), converts it into a proportional 2000 cps a-c voltage, amplifies and filters the signal, and feeds it to a phase detector circuit. The resulting d-c output is passed through a temperature-stable resistor and a transducer winding, connected in series. Current through the resistor provides inverse feedback equal to 99.8 per cent of the input signal, thus

HIGH SPEED SUTTON 5-Roll
STRAIGHTENER AND POLISHER



MODEL 1½ FX
(Pictured)
BARS from 5/16" to 2½" Dia.
TUBES from 5/16" O.D. to 3" O.D.
OTHER SIZES AVAILABLE

FOR FAST AND ACCURATE STRAIGHTENING AND POLISHING OF COLD DRAWN ROUND BARS AND TUBES



- DEPENDABLE SERVICE
- HIGH PRODUCTION
- QUALITY PERFORMANCE

This Sutton model shows the flexibility of the 5-roll principle illustrated at left. While normally only two of the five rolls are driven, this machine has four driven rolls to provide a burnishing action which polishes as it straightens.

Ask for Bulletin No. 25

SUTTON Engineering COMPANY

Manufacturers for Ferrous and Non-Ferrous Metal Industries

STRAIGHTENERS, EXTRUSION PRESSES, HYDRAULIC STRETCHERS, SHEET LEVELLERS, GAG PRESSES, ROTARY CLEANERS, HEAVY-DUTY UNIVERSAL JOINTS, ROLLS.

BELLEFONTE, PENNSYLVANIA

Red Circle Rolls for all Purposes

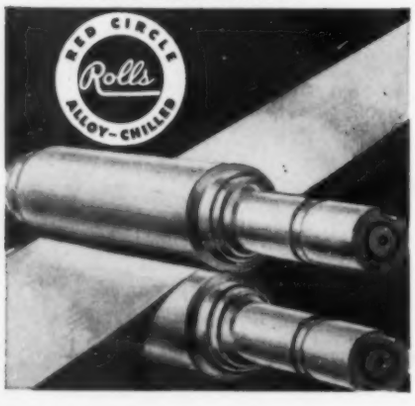
The Red Circle on the Roll is the Hyde Park mark of Quality. Hyde Park makes rolls for every type mill.

Chilled Rolls
Alloy Iron Rolls
Moly Rolls
Nickel Chilled Rolls
Grain Rolls
Cold Rolls
Sand Rolls

for
Finer Finish, Longer Life
and Greater Tonnage
specify Red Circle

Hyde Park

FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS • ROLLING MILL MACHINERY
GREY IRON CASTINGS



minimizing amplifier variations and providing greater stability. Current through the transducer winding provides a magnetic force that positions a flapper-nozzle assembly in the transducer to produce an air relay output proportional to the original d-c measurement. This output is transmitted to an indicator, recorder or controller.

Standard transmitter provides spans as narrow as 10 mv and as wide as 60 mv. Special units with wider spans are available for certain applications. Instrument sensitivity is 1/20 of 1 per cent of scale; accuracy, ±1 per cent of full scale, repeatable to ¼ per cent. For a step-function input of zero to 100 per cent of range (or vice versa) the output signal will change from 3-15 psi (or vice versa) in 4 seconds or less.

MOTOR INSULATION

▲ An all-silicone-rubber insulating system for large motors and generators has been announced by Allis-Chalmers Manufacturing Co. Known as the "Silco-Flex" system, it is immediately available for all class H insulated form wound coils and for class A and B windings operating under certain service conditions.

The development brings insulation engineers closer to the goal of the "perfect" insulation — one that would never deteriorate or change in dielectric or mechanical qualities, regardless of load, during the entire life of the machine.

The insulation makes available the outstanding advantages known to be inherent in silicone base insulations. While all silicone insulations possess outstanding thermal endurance and moisture resistance, silicone rubber, in addition, has the flexibility and resilience formerly obtainable only in organic rubber.

MAGNETIC ROLLS

▲ Production of a new and versatile group of small diameter permanent magnetic rolls is announced by Eriez Manufacturing Co.

Two basic types of rolls, in four different diameters, comprise the new group. All the potentialities of this new magnetic equipment have not been fully explored as yet, but some of the distinct advantages already shown by their use are: faster pickup and more positive control of sheets, tubes and pipes on conveyor lines; re-

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Engineered and designed to eliminate resistor maintenance on troublesome mill applications.

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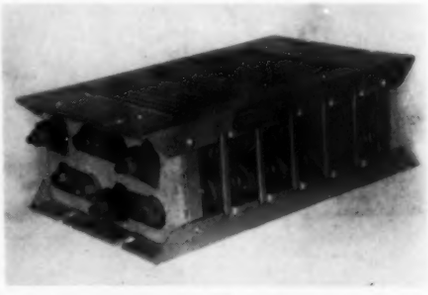

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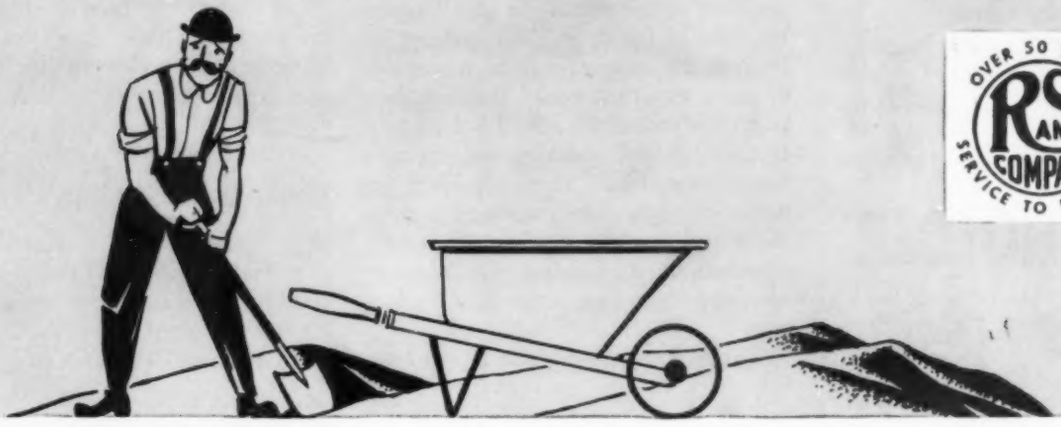

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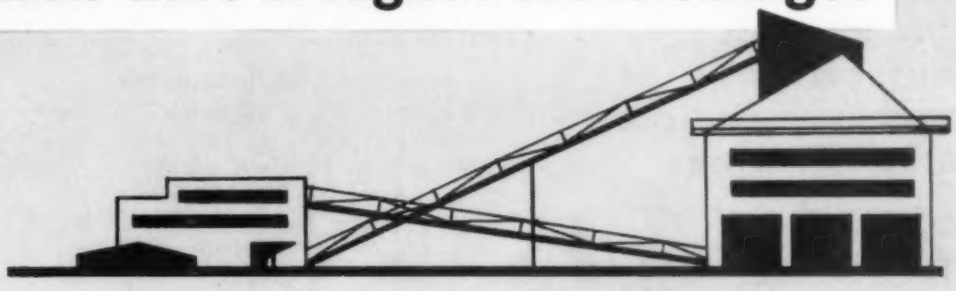
R AND S COMPANY
SERVICE TO INDUSTRY

50 YEARS have brought a lot of changes



—and in the handling of bulk materials Roberts and Schaefer Company has been directly responsible for bringing about many of the changes which have greatly reduced handling costs, speeded and improved movement.

For more than 50 years this organization has engaged in this specialized type of engineering. It has designed and built storage and service plants for many different bulk materials which have shown remarkable savings and efficiencies.

This knowledge and experience is available to you. The Roberts & Schaefer organization is composed of specialized engineers who work as a group to apply their different skills to a single end. The construction force has a nucleus of trained and experienced men who have worked together on many different projects. On a majority of jobs, fabrication is handled in R & S own shops to meet delivery schedules and reduce costs. R & S will assume full responsibility for the complete project from its inception to its completion, or will take over any part where its knowledge and experience will be of help to you.

If you have bulk materials that are processed, hoisted, transported or stored, phone, wire or write for consultation.

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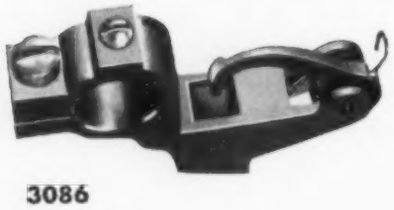

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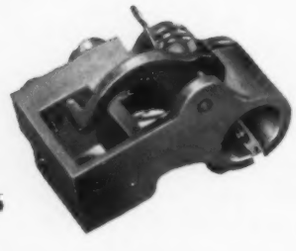

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WRITE FOR CATALOG 4-I

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duction of the conveyor line lengths because of the strong controlling action of the magnetic rolls; assurance of more constant speed because slippage is eliminated; afford better control thereby eliminating cobbles and costly downtime. They are ideal for use in the completely automatic handling and conveying (above or below) of sheets during baking, painting, annealing, stamping, trimming operations.

The first type, designed primarily for sheet feeding and conveying, is built in roll diameters of 4 in. and 5 in. The 4 in. roll has a 1¼ in. shaft and is available in widths from 4 in. to 24 in., in 2 in. increments; the 5 in. roll has a 2½ in. diameter shaft and can be supplied in widths from 4 in. to 72 in., in 2 in. increments.

The second type has been developed to afford spot control in particular conveying problems, employed singly or in any required number. They are manufactured in two sizes; 2½ in. diameter x 1 3/16 in. wide, for use on a ¾ in. diameter shaft; and 4 3/8 in. diameter x 3½ in. wide, for use on a 1½ in. diameter shaft. Both these rolls are furnished with set screws to facilitate quick and simple installation at the precise point or points where contact is desired on the shaft.

LINEAR AMPLIFIER

▲A new electronic low-voltage linear amplifier designed to increase the speed and accuracy of practically all low level d-c voltage measurements is available from Hagan Corp.

This industrial instrument, known as "PowrAmp Model P," is completely compatible inputs from such elements as thermocouples, radiation pyrometers, thermal converters, and d-c strain gages. Applications involve temperature measurement and control, telemetering, automation, and d-c preamplification.

Full scale response of the amplifier is listed as better than 0.1 second. Long-time measurement accuracy is plus or minus ¼ per cent of input range for five Mv and up. Highly useful outputs can be established with input ranges as low as 0.2 Mv.

The unit is available in multiple

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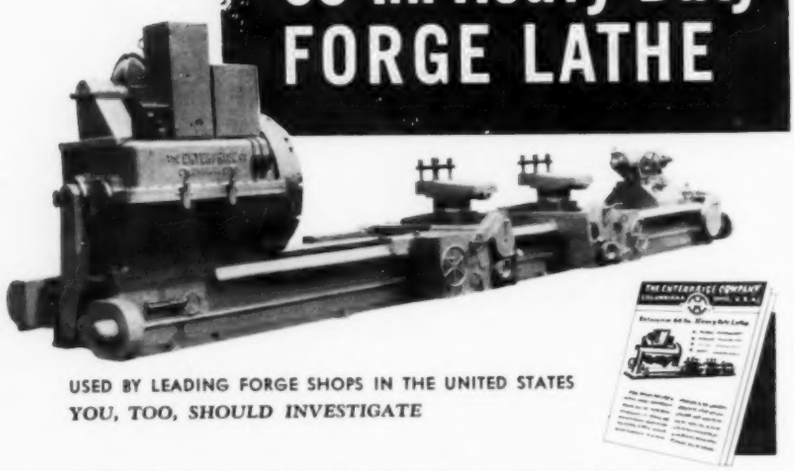

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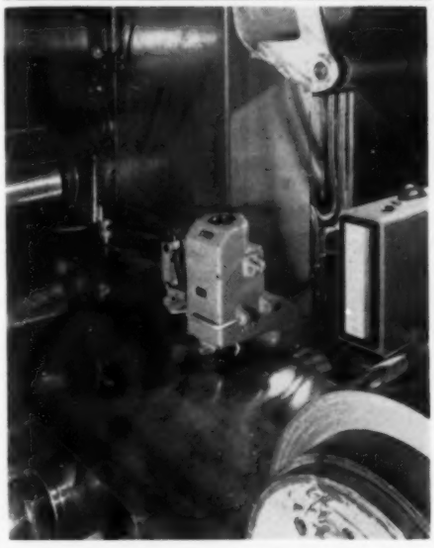
STRIP GAGE



This newly developed Reishauer continuous strip gage, available from Norca Machinery Corp., features a zero setting which is almost instantaneous and can be accomplished without the use of any auxiliary tool in the mechanical or electrical system at choice. Facilities are provided to adjust the pressure of either roll in order to prevent any possible marking of strip. Sufficient gage roll pressure is maintained in order to assure accurate recording of strip thickness.

fixed and adjustable ranges; with fixed or adjustable zero suppression circuits.

CHAIN BRUSHER

▲Dust and dirt which sticks to lubricating oil on hard-to-reach overhead conveyor chains can be automatically eliminated without work stoppage by a new conveyor chain brusher designed and built by the Fuller Brush Co., Machine Division. The danger of the spoilage of material in processing from the dropping of accumulated dirt is eliminated by two sets of wheel brushes which represent a new improvement in brush design.

The unit is mounted on the monorail supporting the chain conveyor, and the two brushes, powered by a one hp motor, pivot on the motor base and bear against the conveyor chain. The brushes can be swung away from the chain if cleaning is desired only periodically.

FORK TRUCK DRIVE

▲Fork lift truck transmission of the torque converter type, available in lift trucks manufactured by Towmotor Corp., permits fast, smooth truck operation and eliminates the need for a clutch or conventional gear shifting.

Known as "Towmotorque," this new type drive has the exclusive creep-control feature which enables the operator to "inch" the lift truck along smoothly when necessary, while maintaining high engine speed for full power lifting, mast tilting or hydraulic accessory operation.

Designed and engineered especially for the rugged duty operation of the fork lift truck, this drive also allows the operator to pre-select forward or reverse while the truck is in motion. It also permits momentary stopping for load pick-up, and starting without need for operating transmission controls.

Unique design features also permit the drive to last the lifetime of the truck with minimum maintenance.

COUNTER TUBES

▲Two new proportional counter tubes for use with Norelco X-ray diffraction and spectrographic units, have been announced by the Research & Control Instruments Division, North American Philips Co.

These tubes are compact, measur-

LAWRENCE

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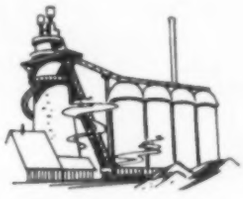

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BOX 246 PITTSBURGH DIST. PHONE 774

ing approximately 4½ in. in length, one in. in diameter, and weighing about four oz. Both tubes have a resolving time of one microsecond. The threshold is a function of the x-ray energy being detected but is always within the range 1400-1800 volts.

Background is 20 to 30 counts per minute with two in. of lead shielding. Operating temperature range is minus 55 C to plus 75 C. Side window is made of mica (weight 1.4 mm/sq cm) and has an area of 5/16 in. by 7/8 in.

Model 1 covers a range on the atomic scale from Aluminum (#13) on up and has a life of 1 billion (10^9) total counts. Model 2 covers a range from Calcium (#20) on up and has an indefinite life. Both are used with standard pre-amplifier and amplifier units and can handle 100,000 (10^5) counts per second with only 10 per cent loss.

BLASTING PALLET

▲ The development of steel pallets which fit the table of a blast cleaning machine exactly permits loading time to be absorbed into the machine operating cycle.

As the system has been developed by Pangborn Corp., a pallet load of castings is blasted clean while the operators are loading a second pallet and preparing it for positioning in the machine. This automatically eliminates the time operators used to spend waiting for the machine to finish a cleaning cycle so they could empty it and put in the next load.

The former cleaning method required operation 24 hours a day, six days a week to keep up with production. The new Pangborn IK table has cut cleaning costs in half and reduced operating time to eight hours a day. The machine cleans at least 22,000 lb of castings (net weight) a day at a cost of well under a penny a lb. Table loading ranges between 2,000 and 5,000 lb with a cleaning time of five to 10 minutes per load.

Most of the castings can be cleaned direct from shake-out, before burning and chipping; maintenance requirements have been negligible; and it has been possible to eliminate 50 per cent of the chipping. Malleabrasive is used in the machine and only 100 lb a day is added in spite of the carry-away inherent in the handling system.

TIMER UNIT

▲ An automatic reset timer with dial setting incorporates high accuracy, compactness, extreme flexibility, and low cost for timing and sequencing of electrical load circuits on industrial machinery and process operations. Manufactured by Automatic Temperature Control Co., the timer has one-piece injection-molded acrylic front piece, serving dual purpose of dust-proof cover and seal for dial. Unique expansion nut assembly fastens cover securely from rear surface and simplifies removal of dial. Large knurled adjusting knob with integral time setting pointer are a unitized part of the dial and cover assembly.

Design makes possible quick external inspection of timer motor operation, clutch engagement, elapsed time pointer operation, pointer reset and load switch actuation, without interrupting operation or process. Full internal inspection claimed possible in two seconds, while operating, by means of pull tab on o-ring retainer at back of cylindrical cover of laminating plastic.

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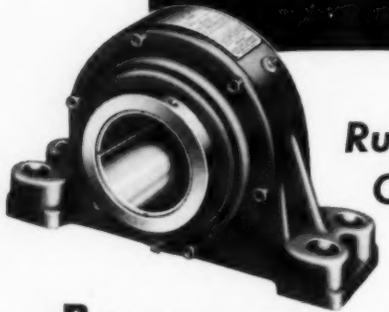

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The Word We Dreaded

My husband and I were together when the phone rang. He got up to answer it and I held my breath as I heard his quiet, "Yes, Doctor?"

Then he put the receiver down carefully. His face, when he turned to me, was gaunt and lined, but he was trying to smile.

"Was it—the laboratory tests?" I asked.

He nodded. "We'd better get my bag packed," he said gently. "They want me in the hospital this evening."

We had realized for months that something was wrong. But the pressure of his business postponed action. "Guess I'm a little off my feed," was all he would say.

It took our family physician only ten minutes to change that attitude. He made an immediate appointment with a specialist. And at the end of an anguished week we knew. The laboratory tests confirmed the word we dreaded—"Cancer."

That was a year ago. Modern cancer research saved my husband. That... and the surgeon's skill, the strength of our faith and his own fighting heart. He is alive and well today. For us the story has had a happy ending.

Yet it *isn't* ended. When we think of the thousands of other families tragically broken every year, we feel we still have work to do. Many types of cancer *can be cured* if caught in time. We tell our friends, "If there are symptoms you don't understand, see your doctor at once." And we *give* to support the constant research of the American Cancer Society in finding the causes and reducing the incidence of cancer.

Strike back at CANCER . . . man's cruelest enemy . . . GIVE

American Cancer Society

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I want to help conquer Cancer.

☐ Please send me free information about Cancer.

☐ Enclosed is my contribution of $____ to the Cancer Crusade.

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POOLE

A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.

In 42 years of exclusive worm gear manufacture, including hob making experience, Cleveland has developed its engineering and production facilities to establish accurate duplication of parts as standard practice.

Photo shows typical hob and gear setup in a hobbing machine.

CLEVELANDS save you money on replacement parts

NOT once in a thousand times will this happen—but, with Cleveland you can order a new gear which will run correctly with an old worm that's still good after working perhaps 20 years or more. That's the kind of service you can expect from Cleveland—and here's why!

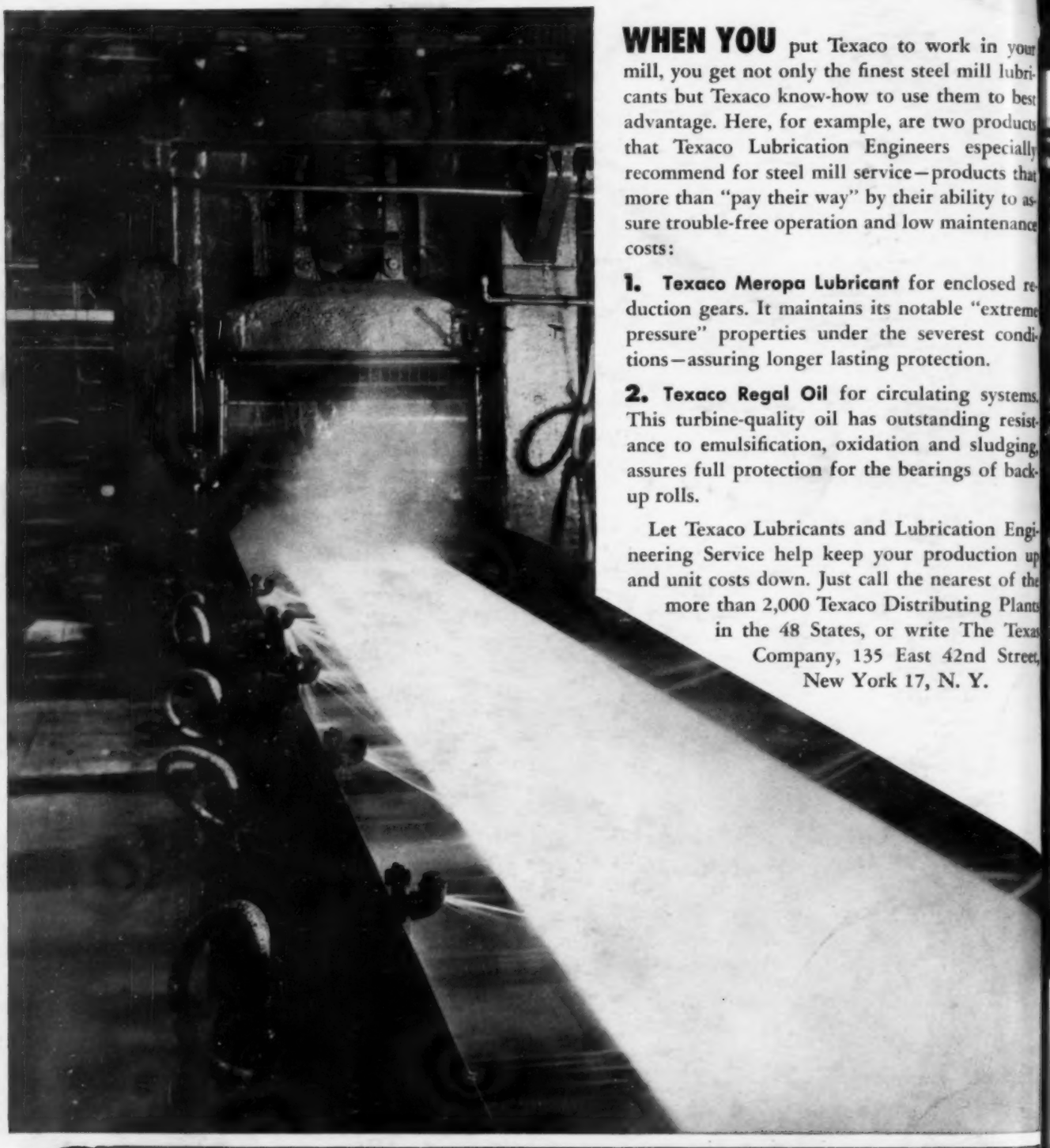
At the Cleveland factory are stored over 1,300 *different* worm gear hobs and master worms. This enables us to duplicate with precision any gear (or worm) that has *ever* left our plant. This means that if a gear *alone* should ever need replacement, you do not have to buy a complete new drive. Instead, just give us the particulars on your Cleveland speed reducer, no matter how old—10, 20, 30 or even 40 years! In short order, we'll have a new gear ready for you—one that will run perfectly with the older worm.

By supplying parts on this basis, Cleveland may be able to save you the cost of a *complete* new drive or the extra expense of special tooling. Isn't this the replacement protection you want when you buy worm gear drives? The Cleveland Worm and Gear Company, 3278 East 80th Street, Cleveland 4, Ohio.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Worm Gear
Speed Reducers

MORE STRIP COMES OUT...
LESS COST GOES IN



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